

The Blast Furnace *and* Steel Plant

Need for High Air Pressures in Converters

Report on Experiments Carried Out With Experimental Apparatus to Determine Effect of Blast Pressures in Bessemer Tuyeres—Atomization of Charge Condition Sought.

By W. TRINKS.

Practice has settled on blast pressures of 20 to 30 pounds per square inch for converters. Among those who are not thoroughly familiar with converter practice the impression prevails that this high pressure is necessary to deliver the air against the pressure caused by the liquid iron (ferrostatic pressure). Calculations based on actual converters show, however, that ferrostatic pressure at the bottom of the vessel varies between the units of 3 to 5 pounds per square inch, so that the question arises: Why the other 17 to 25 pounds? For the purpose of solving this question a test apparatus was installed in the Mechanical Engineering Laboratory of the Carnegie Institute of Technology. This apparatus was described and illustrated in **The Blast Furnace and Steel Plant**, January, 1916.

Among the theories advanced for the necessity for the high blast pressures is the contention that the excess pressure is needed to keep the molten iron from flowing down into the tuyeres. It is well known that air and liquid of equal pressure, filling a pipe, will arrange themselves so that the liquid is at the bottom. It has been claimed that the iron would flow back, if it were not for the very great speed with which the air flows upward through the tuyeres.

In order to test this theory, the 6 in. pipe constituting the experimental converter was filled with mercury to such a height that the pressure at the bottom, that is to say at the mouth of the tuyere, was 4 pounds per square inch. The tuyere was 21 in. long, with a diameter of $\frac{1}{2}$ in. The converter tube was righted from horizontal to vertical position with a pressure of about 10 pounds per square inch. The pressure was then gradually reduced, until the mercury ran back through the tuyere. This point was determined by the appearance of the mercury in a gage glass under the tuyere. Much to the surprise of the observers, the mercury did not appear in this gage glass until the pressure had been lowered down practically to that exerted by the mercury at the mouth of the tuyere, that

is 4 pounds per square inch. The experiment was repeated several times by different sets of observers, and with different depths of mercury. The result was invariably the same, namely that the mercury did not run back through the tuyere until the air pressure equaled the static pressure of the liquid. It is therefore apparent that with openings as offered by the standard tuyeres ($\frac{1}{2}$ to $\frac{5}{8}$ in.) the high blast pressures now in use are unnecessary as far as preventing the running back of the iron is concerned.

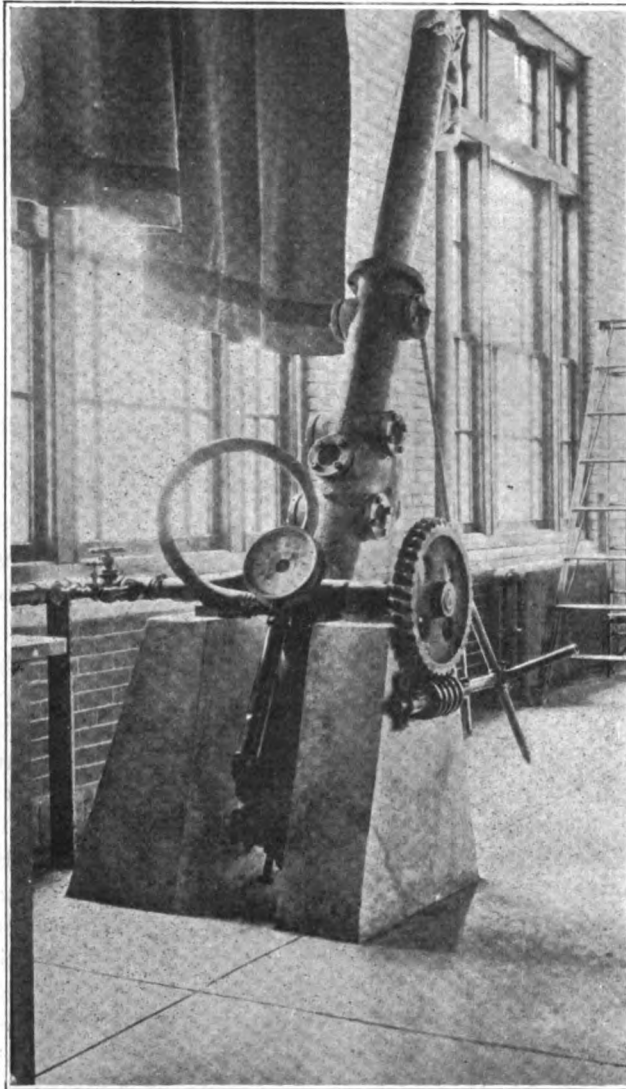
And yet experience teaches us that high blast pressures are necessary for successful converter operation. Some information on the reasons for such necessity can be gained by watching the mercury in the Carnegie Tech. installation while air is being blown through the metal. If the blast pressure is gradually increased, the behaviour of the mercury in the tube changes remarkably. With low pressures, say from five to ten pounds per square inch, bubbles of air rise through the liquid, giving it the appearance of a liquid boiling in an open vessel. With 12 to 15 pounds pressure, chunks of mercury fly up $2\frac{1}{2}$ to 3 feet, but they are still compact. As the pressure rises to 18 pounds or thereabouts, the mercury spouts at times to a height of 4 or 5 feet. The liquid is no longer compact, but is in the shape of drops anywhere from $\frac{1}{8}$ to $\frac{5}{8}$ in. diameter. As the pressure is increased to 22 pounds, the drops become smaller, and at 30 pounds the mercury is so well atomized that at times it appears like a gray mist of fine globules of metal. The spray of drops rises to more than 12 feet. How much more, we do not know, because it leaves our tube. However, very little mercury escapes, because a cloth bag, tied fast to the end of the tube, catches the spray. What little escapes, is very finely subdivided and might almost be called mercury vapor. For reasons of health of the observers the pressure of 30 pounds per square inch is not kept on the apparatus very long. Besides, the whole apparatus shakes violently at the high pressures, because practically the whole

body of mercury rises and falls intermittently.

It is evident from these tests that higher and higher blast pressures mean finer and finer subdivision of the liquid iron in a converter. Low blast pressures mean large bubbles of air which escape, before their oxygen has been entirely absorbed by the iron. Blast

extends from about 22 pounds to about 32 pounds per square inch, depending upon the size of the converter.

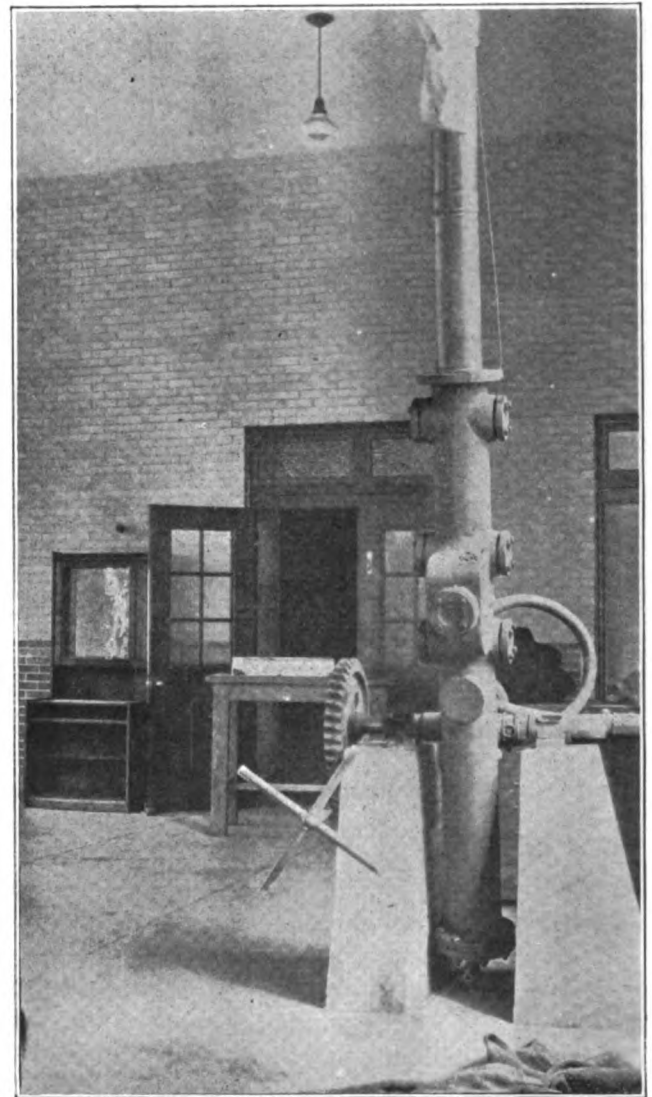
The results of the Carnegie Tech. tests, while made on a small scale, are nevertheless representative, because opening and length of tuyere coincide with those used in practice, and because the ratio of tuyere area to cross sectional area of converter is the same as used in practice, namely approximately three-fourth of one per cent. A slight difference may come in from the fact that the viscosity of molten iron probably differs from that of mercury. Furthermore tuyere



Pressure gauge location on converter.

pressure should be high enough, and the subdivision of air and metal should be carried far enough, until the discharged gases are free from oxygen. Additional subdivision will serve no useful purpose.

Converter practice then has to decide between large quantities of air at low pressure, or smaller quantities of air at high pressure. As we pass from low pressures to higher pressures, subdivision of air and metal becomes finer and finer, but the gain becomes smaller and smaller. Finally a loss appears, because first, blast pressures become excessively high, which fact means useless power consumption, and second, because too much metal is lost through the mouth of the converter. Practice has shown that the practical range



Long tube for catching atomized metal.

length changes in practice, because tuyeres burn down from almost two feet length to less than 10 in. length in six to eight hours. But none of these differences can seriously affect the mechanical effect of air of different pressures upon liquid metal, so that, as before stated, the experiments with the mechanical converter at Carnegie Tech. may well be taken to depict what is going on in the actual metallurgical converter.

Formulae for Finding Large Gas Volumes

Discussing Prof. Estep's "Measuring Gases by a Standard Orifice" Appearing in January, and Offering Some Simplified Expressions for Finding Constant Used.

By H. G. GEISSINGER, Consulting Engineer, New York City.

There appeared in the January issue of **The Blast Furnace and Steel Plant**, two very useful discharge curves for the flow of air and natural gas, through standard orifices. The readers will surely appreciate the labor of plotting these curves from the involved formula noted on page 31.

It may be of interest to those mathematically inclined, and be of practical service in determining any definite value of **K**, to know that this factor can be determined by the use of simple formulae.

The writer would invite re-examination of the discharge curves in the last issue. The curves are based on the ratio of absolute pressures, but it will lead toward simplification to plot the ratio in the dimension of 1—Ratio. In the air curve the base will be numbered from 1 to 0.47. The base then represents the drop of pressure across the orifice, divided by the absolute pressure on the entering side. Calling the base values **d**, we have;

$$d = \frac{P' - P''}{P'}$$

It is apparent that the curve starts as a square-root function, as it should. At any small drop of pressure, and negligible expansion of a gas, the velocity follows the rule for liquids, viz., as the square-root of the head. It is, of course, apparent that the curve does not follow this simple derivation, but terminates in a horizontal line.

The shape of these gas discharge curves, suggests that their formulae might be expressed by the equation

$$y = \sqrt{x - p x^2}$$

for when **x** is small, **x**² may be neglected, and the formula may be read,

$$y = \sqrt{x},$$

this satisfies the first condition.

Again, curves of this construction reach a point of maximum value. At this point in the curve the differential, or slope, becomes of zero value. When **y** is at its maximum value, the square of the curve would also be at its maximum, and horizontal, and $y^2 = x p x^2$.

In this formula the differential,

$$\frac{dy}{dx} = 1 - 2 p x.$$

When the differential is zero,

$$2 p x = 1 \text{ and } p = \frac{1}{2 x}$$

This formula would therefore satisfy the second condition.

Let us apply this formula to the air curve; in the proposed nomenclature, the formula for the maximum value of **K** would read;

$$K_m = q \sqrt{d - p d^2}$$

wherein **d** is taken at its maximum value, 0.47. Also

$$p = \frac{1}{2 x} = 1.06 \text{ and}$$

$$K_m = q \sqrt{d - 1.06 d^2} = q \sqrt{0.47 - 0.235} = 0.485 q$$

As it has been otherwise determined,

$$K_m = 0.532 \text{ we have } q = 1.1.$$

Inserting the square of the value of **q** under the square-root sign, we have;

Km (or any intermediate value of "K")

$$= \sqrt{1.21 d - 1.28 d^2}$$

In example; find the value of **K** for the ratio pressure 0.9 wherein **d** = 0.1

$$K = \sqrt{0.121 - 0.013} = 0.328$$

The above rule for determining the value of any point of the discharge curve is exact, and applies to the discharge of steam, as well as of gases.

Derivation of Practical Formulae for Critical Ratio and "K."

Referring now to the formula given by Prof. Estep for determining the critical ratio of pressures; if **n** be taken as 1.4 we have the ratio; $P'' / P' = 0.835^{3.5}$ or 0.53, if **N** be taken as unity, we have; $1^{inf.} = 1$. The latter is, in fact, indefinite, the extension of a plotted curve of the critical ratio, shows a value at $n = 1$ of 0.605.

Further study of this curve shows that the critical ratio may be very exactly represented by a simple formula.

It frequently happens that very complex equations may be reduced to simple forms, without loss of practical accuracy, and this proves to be the case in determining the critical ratio, and corresponding value of **d**.

For any known value of **n** we may take the maximum value of **d** as;

$$d_m = \frac{n}{1.44 + 1.1 n}$$

Therefore we can now offer a general formula for determining the value of **K** corresponding to any value of **d** (less than the maximum), from the char-

acteristics of the gas expressed by the values of R and n ;

$$W = \frac{A \cdot P' \cdot K}{\sqrt{T}}$$

Wherein

- W = discharge, pounds per. sec.
 A = net area orifice, square inches.
 P' = pressure before orifice, pounds per square inch absolute.
 d = drop in pressure across orifice, pounds per square inch.
 T = absolute temperature entering gas, F.
 g = acceleration gravity, 32.16.
 n = ratio specific heats, constant pressure, to constant volume.
 R a constant for the gas in question.

Let;

$$r = \frac{2g}{R} \text{ and } f = 1 - \left(\frac{1.4 - n}{10} \right) \text{ and } p = 0.55 + \frac{0.72}{n}$$

Then;

$$K = \sqrt{r \cdot f (d - pd^2)}$$

As examples are interesting and convincing, we offer the following;

Determine K for a drop ratio of $d = 0.25$ (pressure ratio 0.75), in natural gas, where $n = 1.27$ and $R = 4$. From this data we find;

$$r = \frac{64.3}{94} = 0.683$$

$$f = 1 - \frac{(1.4 - 1.27)}{10} = 1 - 0.013 = 0.987$$

$$\text{and, } p = 0.55 + \frac{0.72}{1.27} = 0.55 + 0.565 = 1.115$$

Therefore,

$$K = \sqrt{0.675 (0.25 - (1.115 \times 0.0625))} = \sqrt{0.122} = 0.35$$

The quantities noted in the above formulae, have been determined by slide-rule calculations. Any errors introduced into the formula will, however, be of much less moment than the inevitable errors of observation.

Metalloid Removal from Metal Washing

Discussing "Washed Metal in Special Steel Making" by Henry D. Hibbard in the January Number, and Giving Brier Hill Process and Results at That Plant.

By EDWARD L. FORD.

In the accompanying diagram (Fig. 2) showing the removal per cent of metalloids in washing, the rate of elimination of each seems to be constant for about the first 10 minutes, and (with the possible exception of sulphur) the angle which the line of each makes with the base line probably represents the relative net heat results of each complete reaction. I use the word "complete" because the net result is the sum of a number of things: In the case of silicon, for example, the heat + or - from Si to SiO_2 ; from FeO to Fe ; from FeO_2 to FeO ; the formation of silicate by the silica; the liquefying of this silicate, etc.

Why these rates should not remain constant up to complete elimination is due to a number of things—changes in temperature, changes in character of atmosphere, changes in composition of slag and resultant metal, and very possibly other causes. We have worked out some of these; and, although they may not be the only factors, they seem to explain fairly well what happens.

Silicon.—The rate of silicon removal is constant to about 95 per cent, when it begins to become less rapid. This, I think, is due entirely to the want of perfect mobility of the slag and metal, and therefore

Discussion of paper read before the American Institute of Mining Engineers.

to the fact that the silicon is not present in equal amount in all parts of the metal at this stage of the process. In fact, it must take an appreciable amount of time for the metal in the center of the mass to reach iron oxides on its surface.

Manganese.—Manganese seems to behave in the same way, although the rate of removal is a little less rapid. Its retardation at the end is due to the same causes.

Phosphorus.—The phosphorus removal-rate is constant to about 70 to 75 per cent, when retardation sets in, and progressively increases, the line tending to parallel rather than intersect the 100 per cent line. The long time required to remove phosphorus, as compared with silicon and manganese, would make the lack of mobility at this stage a factor of practically no consequence; but, after the elimination of silicon, carbonic oxide begins to be formed; and (as Pourcel showed very clearly, in the early days of the basic Bessemer process, in the discussion the necessity for the overblow to remove the phosphorus) phosphorus cannot be removed from iron when CO is being formed intermolecularly in quantity; and no doubt the proportion of phosphorus removed is inversely related to the amount of CO formed, during a given period. True, the formation of CO , by lowering the temperature of the bath, tends to stop it-

self; but it completely ceases only when the metal is so cool that it begins to set; and this, of course, impairs the fluidity necessary to bring new surfaces of metal in contact with the slag, in order to oxidize the small amount of phosphorus left. We, therefore, finally reach a point of equilibrium when the CO formed just reduces the amount of phosphorus oxidized. If we increase the heat of the furnace, to increase the fluidity of the metal, we increase again the amount of CO that can form, and so are no better off than we were before.

Sulphur.—Our theory of the elimination of sulphur I have never seen formulated and would hesitate to report it here, if I were not trying to give the rationale of the washing process, as we have known it. Even at quite a low temperature, sulphur appears to form sulphides, preferably to oxygen compounds; and

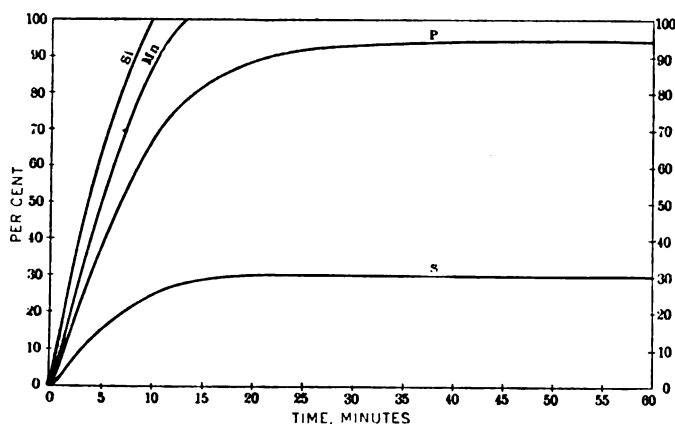


Fig. 2.—Removal of metalloids in washing.

as the temperature increases, this tendency seems more marked. In neither the blast furnace, the converter, the open hearth, the puddling furnace, nor in our washing process, is the sulphur removed, except as a sulphide. In roasting sulphurous iron ores, however, it does go off as SO_2 ; but this process, as is well known, is performed at as low a temperature as possible. Our view is that for any given temperature, atmosphere, slag, and metal composition, the amount of sulphide in the slag bears a constant ratio to the amount in the metal. That there is an equilibrium, so to speak, which can not be altered without a change in one, at least, of the controlling factors above mentioned. In our own process, as carried out by us, the ratio seems to be one in the metal to five in the slag, or, to put it in another way, a slag with 0.10 per cent sulphur will give a metal with 0.02, and to get 0.01 sulphur in the metal the slag must not have more than 0.05 per cent. As corroborating this proposition, the two following incidents may be interesting:

On one occasion pig iron with 0.025 per cent sulphur was run into the washing furnace at a time when an accident at the blast furnace had let some blast furnace cinder get into the receiver together with the pig metal. Some of this cinder ran with the

metal into the washing furnace. The resulting washed metal carried 0.04 per cent sulphur. With our ordinary practice this would have been about 0.017 per cent.

Some washed metal with 0.015 per cent sulphur was melted in a cupola with coke. The resultant metal ran 0.10 per cent sulphur. Some white iron with 0.10 per cent sulphur was melted in the same cupola. Result: sulphur, 0.11 per cent. We had on our yard a heat of washed metal, containing 0.09 per cent sulphur. This was melted in the same cupola. Result: sulphur, 0.12 per cent. These results seemed to point to from 0.10 to 0.12 per cent as the equilibrium point in the resultant metal from these operations, no matter what sulphur the metal contained to start with.

With the above statement of our sulphur theory, the following is our explanation of the sulphur line in the diagram:

This sulphur line probably has only this relation to those of the other metalloids, that it tends to become tangent always directly below the point of complete silicon elimination, because at this time ends the formation of new sulphur-free slag, capable of taking up more sulphur from the metal. The percentage removal, therefore, varies with the sulphur contents of the iron, in contradistinction to the other metalloids, the percentage removal of which is constant.

Low-sulphur washed metal is the only marketable product; hence we aim to keep the sulphur in our pig iron as low as we can, with low-silicon iron. Our "fix" ores contain a little sulphur; the gas from our producer carries a little; and our limestone a little; so that the resulting slag, if none came from the pig iron, would run about 0.03 to 0.04 per cent as a minimum. Our practice shows us that, in a metal containing 0.007 per cent sulphur, this would give us no removal.

If we could obtain raw slag materials absolutely free from sulphur, our washed metal would be 0.007 per cent lower in sulphur with our regular pig iron than it is now. If we were satisfied with 0.05 per cent sulphur in our washed metal, we could use a pig so high in sulphur that the amount taken out would probably approximate 60 per cent, rather than 30, as now; for when we formed our second slag, it would be capable of taking up a considerable portion of this remaining sulphur, before reaching the equilibrium point.

If the other conditions incident to the process permitted it, we could, by making new slags, reduce any amount of sulphur in the pig to about 0.01 per cent, but we could never get much lower than that, no matter how low the pig was, as long as our slag-making materials were as high in sulphur as they are now.

Our experience teaches us, however, that the blast furnace is the best and cheapest desulphurizer.

Some Causes of Colors in Furnace Slags

Influence of Temperature, Volume, and Chemical Composition
on Slag Colors—Relation of Color to Chemical Components.
Practical Value of Color to Furnace Conditions.

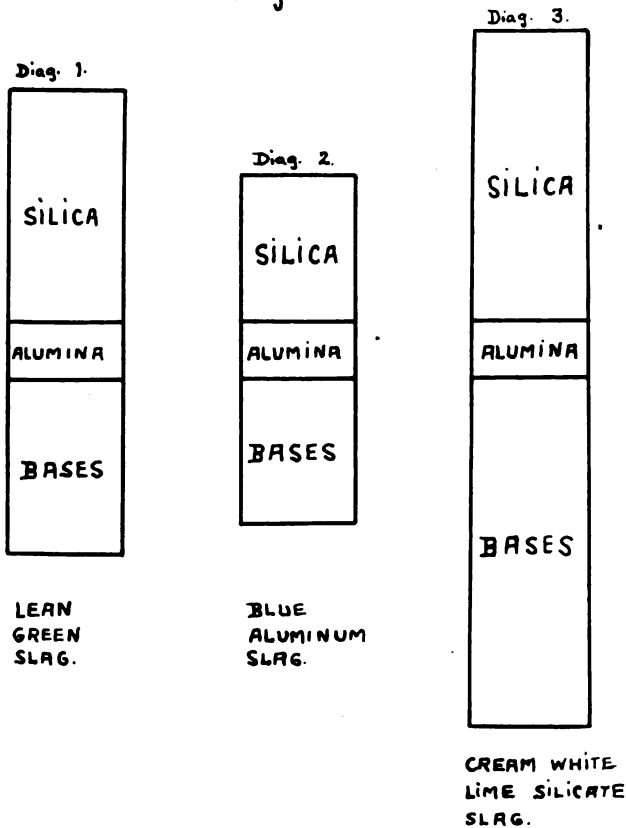
By WALLACE G. IMHOFF.

The most common colors of blast furnace slags are various shades of gray, blue, black, brown, yellow, white, bottle green, and olive green. Just as the thread on a lean slag is an indicator of slag composition, so is its color, but a little more effort is required to understand it. In other words little knowledge of the chemical composition is required to judge by the thread but a much more detailed study of slags must

proportion to the shade of black. This statement should not be confused, for one must remember there are slags of all melting points according to the proportions of their make-up, but for any given make up if it is black it will be cold, though the temperature may be extremely high.

It is interesting to note the chemical elements which cause the various colors. Starting in the order given we first arrive at the various shades of gray. The mistake has often been made of attributing the gray color to lime but on second consideration we all know lime is pure white. This mistake is due to a misconception of what has actually happened and

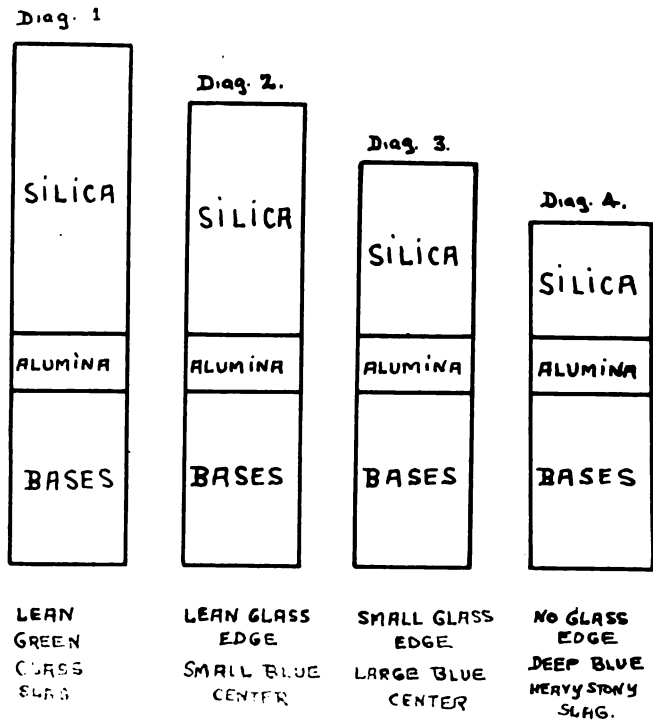
Figure 1.



be made before one can properly understand the significance of color.

The color of slags is an indicator of temperature, slag volume, and chemical composition. The many shades all correspond to the various degrees of furnace conditions and the slightest change of any condition will alter the color to some extent. As an example take the various shades of black with which most furnacemen are very familiar. Starting with white, which represents a very high hearth temperature, and passing through all shades of white to black, which represents a very low hearth temperature, we find that the temperature at any point is in direct

Figure 2.

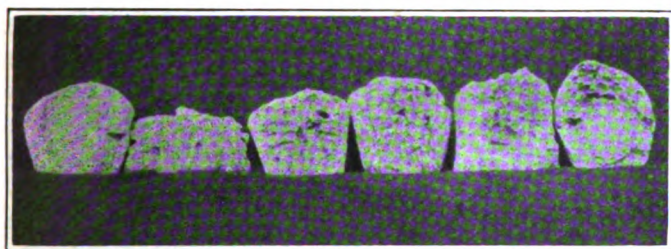


what we see. As an example take a very dark gray sample which slacks to a powder and it seems evident that the lime has given it its gray color. Note what has really happened; there are three main components, lime, alumina, and silica. Alumina colors slags blue, but the high hearth temperature has reduced the slag volume by putting the silica into the iron as silicon, thereby concentrating the lime and alumina. Silica makes slags stony, lime makes them go to powder,

hence with an extreme decrease of silica the tendency to go to powder, and due to the reduction in slag volume the blue has become concentrated and gives the slag the extreme dark gray color.

As the silica increases or in other words as the hearth temperature is lowered the dark gray becomes gray and the tendency to go to powder ceases. With still further increase in silica the tendency is to show a vitreous fracture and the color then becomes blue. Thus then the various shades from extreme dark gray through gray to blue and light blue can be attributed to alumina. The shade of coloring is a function of temperature, and slag volume, while the appearance of the fracture depends on relative proportions of silica to lime or vice versa.

The various shades of black are caused by the



Deep blue to gray heavy, solid, stony samples. Small slag volume. These samples represent less silica than shown in Diagram 4, Figure 2. Some are already almost ready to slack. The end samples show the solid, stony types.

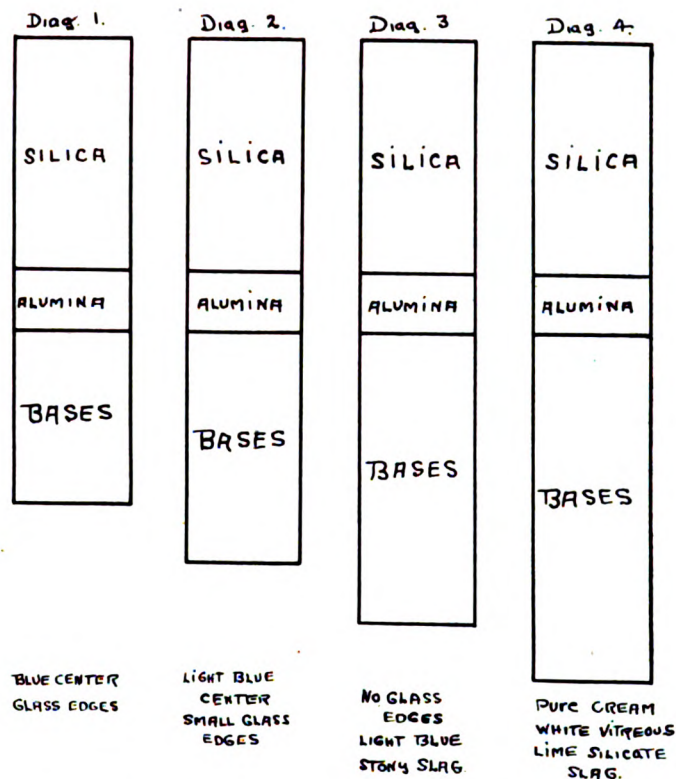
varying amounts of iron oxide in the slag. The iron oxide serves as a temperature indicator and indeed is very reliable. The color is due to the different proportions of the lower oxide of iron, FeO , and the colder the slag the blacker the surface on cooling. A pure white slag indicates a very high hearth temperature, an ink black slag a very cold hearth temperature, while the various shades between indicate the proportionate temperature between.

The various shades of yellow, olive green, and brown, are caused by varying proportions of manganese. Here again hearth temperature is of vital importance for with a high hearth temperature it is possible that little or no manganese coloring will be seen in the slag. With a drop in temperature the manganese at once begins to appear and depending on its amount may color the slag a light yellowish green, a deep olive green, or a deep shade of reddish brown. The darker the brown the colder the slag and vice versa.

Pure white slags either powdered or vitreous get their color from lime. In the powdered white slags the heat has been so intense that all the oxides of iron and manganese have been reduced and therefore there remains but the lime to give it a distinctive coloring. In what might be termed a strictly lime silicate slag the color is more of a cream white than a pure white and the fracture also shows a vitreous, or glassy surface. This type of slag represents a very large slag

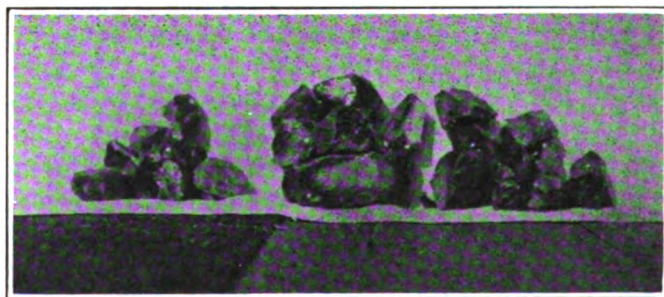
volume and also a low hearth temperature. By this is not meant a cold hearth temperature but a low hearth temperature due to the large mixture of the two main slag components silica and lime. In such large propor-

Figure 3.



tions the melting point is very low. These slags are typical slags of a basic furnace with large slag volume and low hearth temperature, while the former white powdered slags are typical white hot foundry slags with a high hearth temperature and small slag volume.

The various shades of bottle green slags are generally found on lean furnaces. The hotter the slag



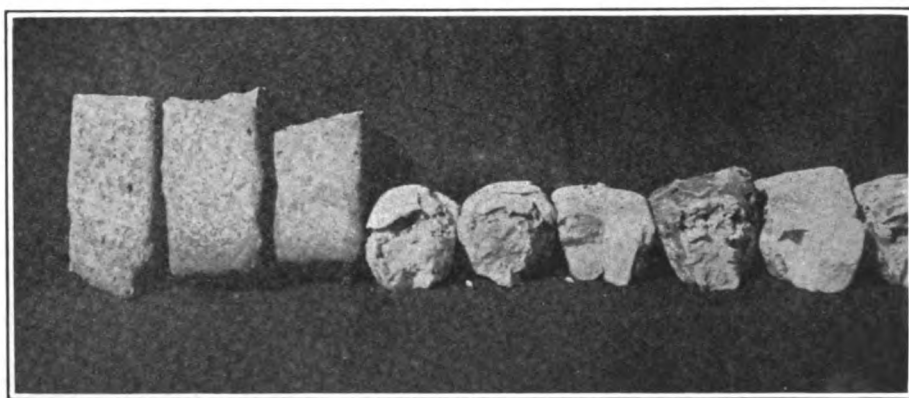
Lean Slags.—Middle pile: lean glass edge, small blue center; see Figure 2, Diagram 2. Pile to right: lean slag; see Figure 2, Diagram 1. Fairly large slag volume.

the lighter the shade of green and the colder the slag the darker the shade of green. Just what this green color is due to, the writer can not definitely say, but it seems to be caused by iron. In any slag it takes but a very small amount of a component to give it color and it may be due to very small amounts of iron

which still remain in the slag at this high temperature.

Often lean glassy slags are brown in color. Here again is the question of temperature. Hot lean slags are green, and with manganese present cold lean slags are brown. Another feature which is a function of temperature is the surface of the fracture. A hot lean slag will show a very shiny, vitreous fracture, while the same slag cold would have a dull glassy fracture.

The temperature indicators are iron, silica, and manganese. On a hot furnace the coloring due to iron and manganese is at a minimum while at the same time the silica has decreased in proportion to the heat. The heating value of any slag is in direct proportion to the mixture of its components. For example a very highly acid slag will carry less heat



This iron is heavily limed. The slag samples correspond about to Diagram 3. Figure 3. Fairly large slag volume and of the solid stony type. Note the solid sample in the center.

than a very highly basic slag. Lime has a much higher melting point than silica, therefore the more lime the higher the melting point and the greater the heat of the slag. Lean slags lose their heat very quickly while limy slags are very hard to heat up, but they also hold their heat after they have once received it.

Just how slag volume can effect color requires a little explanation. Change of color in this instance is affected by degree of concentration and this in turn is brought about in two ways, first by change of actual weights of ore, coke, or stone on the scale beam, and second by degree of hearth temperature. The degree of hearth temperature affects the slag volume in the fact that it increases or decreases the silica in the slag. Thus with a very hot bottom the silica is reduced and the concentration of the slag increased, giving it a deeper blue color. If the lime is light the color will be deep blue, due to the automatic increase in the proportion of alumina.

The following diagrams will serve to simplify the illustration. Actual percentage values of the components are purposely omitted. The idea is to show how concentration will affect the color. The alumina is assumed to be nearly constant at all times.

In Diagram 1 the amount of silica is very large in proportion to the amount of alumina and bases hence the slag would be a lean green glassy slag. In Diagram 2 the amount of silica and bases are smaller, thus automatically increasing the amount of alumina which would give this slag a characteristic blue aluminum color. In Diagram 3 the amount of silica and bases are very large, which automatically decreases the proportion of alumina, hence a lime silicate slag which has a cream white color. It is at once seen then how all shades of color may be obtained by change of slag volume. These colors predominate on a hot bottom, but if the bottom becomes cold they may be overshadowed by black from iron oxide, or brown from the manganese.

It is very interesting to note the change of color assuming any two of the components constant and varying the third. In Figure 2 we will assume the lime and alumina to be constant and see what happens by decreasing the silica which is easily done by increasing the hearth temperature.

In Diagram 1 we have a lean green glass slag entirely due to the extreme excess of silica. In Diagram 2 the slag has a small blue center with large glass edges. In Diagram 3 the silica has decreased so much that the whole central part of the sample is blue and only the edges are of glass and finally in Diagram 4 the glass has disappeared entirely and the slag is a deep blue heavy stony slag.

In ordinary practice the actual amount of alumina varies but little and therefore it will be assumed to be constant and no diagrams will have to be made for it.

Again assuming the lime to be the variable and the silica and alumina to be constant the following color changes are noticed. As can readily be seen the intensity of any color depends entirely on the actual amount of the components present.

In Diagram 1 the sample shows a bluish center with glass edges. In Diagram 2 with an increase of lime the center becomes a lighter blue and the glass edges are smaller. In Diagram 3 the glass edges have disappeared and the sample is now a lighter blue still and is solid and stony. In Diagram 4 the sample is a heavy cream white solid stony sample. With a large enough increase in lime the sample may slack to a white powder.

All this color scheme may easily be worked out in practice by varying one component and keeping the others constant and watching the slags closely. It is essential that it be carried out under a uniform hearth temperature for as stated before slag volume

is affected in two ways, by actual variations on the stock house scales and by raising or lowering the hearth temperature.

In regard to the chemical composition it can be readily seen now how the changes going on in the furnace can be judged from slag colors. One of the most important things in determining the composition of any slag in order to make that slag serve the operator's purpose is to use all the constants available and eliminate as many variables as possible. For

example the wind is constant, the stove heat is a constant, and the lime is fairly constant. No slag can remain the same if all these constants are turned to variables and changed at will. To make any regular run of iron all these constants should be fitted to each other and then left alone as much as possible. When this has been done the regularity of color will easily be seen and the color changes may also be noted in proportion as the changes occur in temperature, chemical composition, and slag volume.

Mill Design for Rolling Flat-flanged Beams

Rolling Schedule for Special Shapes in the Grey Mill With Sizes and Shapes Available With That Equipment—Means for Strengthening Grey Mill Sections.

By F. DENK.

In 1899, Henry Grey patented his universal mill for rolling wide flanged beams. This mill consisted of two stands located close together. The first stand, "A," Fig. 14, has two horizontal rolls, which are equal to each other; the second stand represents the universal mill proper, with one pair of vertical and one pair of horizontal rolls, "B," Fig. 14, the rolls of both sets being equal and symmetrical to each other.

Notwithstanding the fact that this new type of a mill showed distinct advantages over any other type which had been used for rolling wide flanged beams, manufacturers in the United States refused to acknowledge these advantages and even went so far as to refuse to believe in the possibility of rolling wide flanged beams satisfactorily in the mill in question. Thus it happened that this originally American invention was first taken up in Germany and put into operation at the steel works at Differdingen, near Luxemburg, in 1902.

The general arrangement of this mill is shown in Fig. 15, illustrating the universal mill only. The process of rolling is as follows: The ingots are broken down in a blooming mill, a general design of which is given in Fig. 8 (see December issue of this magazine). The rolls of this blooming mill are about 8 feet long with an average diameter of 43 inches. The ingots are rolled down in 13 passes to a rough H-shape (Fig. 14 "C") to a length of between 16 and 20 feet; they then pass a hydraulic shear, where the ends are cropped. From there the beams are delivered to a heating furnace, where they are reheated, in order to remove internal stresses, which might have set up during the preceding rolling in the blooming mill. The rough H-beams then enter the auxiliary stand of the universal mill, "A," Fig. 15, and from there the main stand of the universal mill with the horizontal rolls "B" and the vertical rolls "C," Fig. 15,

these latter two sets of rolls forming the universal mill proper. In these universal rolls the surfaces of web and flanges are worked upon, and the thickness of the web is determined by the distance between the two horizontal rolls. The auxiliary rolls, on the other hand, work on the outer edges of the flanges only, and the width of the flanges is determined by the size of the collars "a" (Fig. 15). In order to prevent bending of the flanges during the latter process,

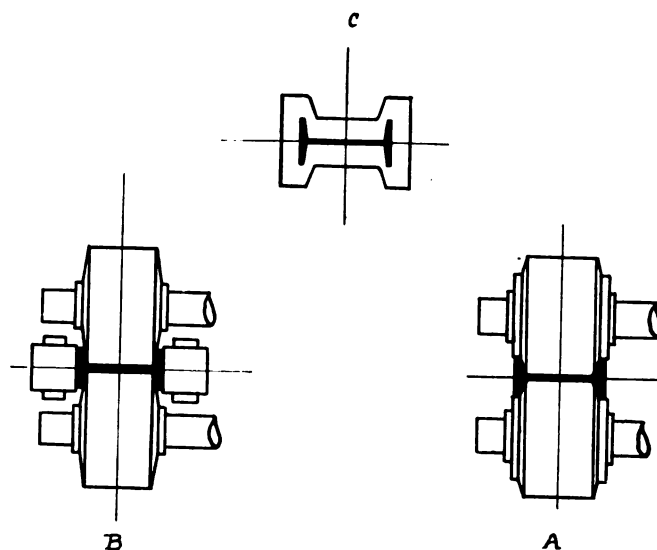


Figure 14.

the beams are held in position by strong guides (not shown in Fig. 15); the distance between these guides can be regulated to suit the rolling conditions. During rolling, the beam is never turned; it simply runs back and forth through the two sets of rolls (auxiliary and main stand) until the desired size and section is obtained.

The small vertical rolls are not driven independently from the main rolls but taken along by the flanges

of the beam. Besides, they are pressed against the collars of the horizontal rolls "B" by means of hydraulic cylinders, thus also being forced to revolve on account of the friction between the two sets of the rolls.

The lower horizontal rolls are fixed and therefore immovable, while the position of the upper horizontal rolls and that of the vertical rolls can be regulated. This regulation can either be done simultaneously for all rolls, or independently, each roll being moved separately. The same takes place for the guides,

condition. The finished beam leaves the rolls through "B".

The main advantage of this type of mill is that the outsides of the flanges are worked over their whole width with a uniform velocity by the vertical rolls "C", while on the inside of the flanges the difference in velocity is immaterial, on account of the large roll diameter (about 43"). If this will be compared with the conditions illustrated in fig. 2 (November issue of this magazine), the advantage will become evident. A further advantage lies in the fact, that with one set

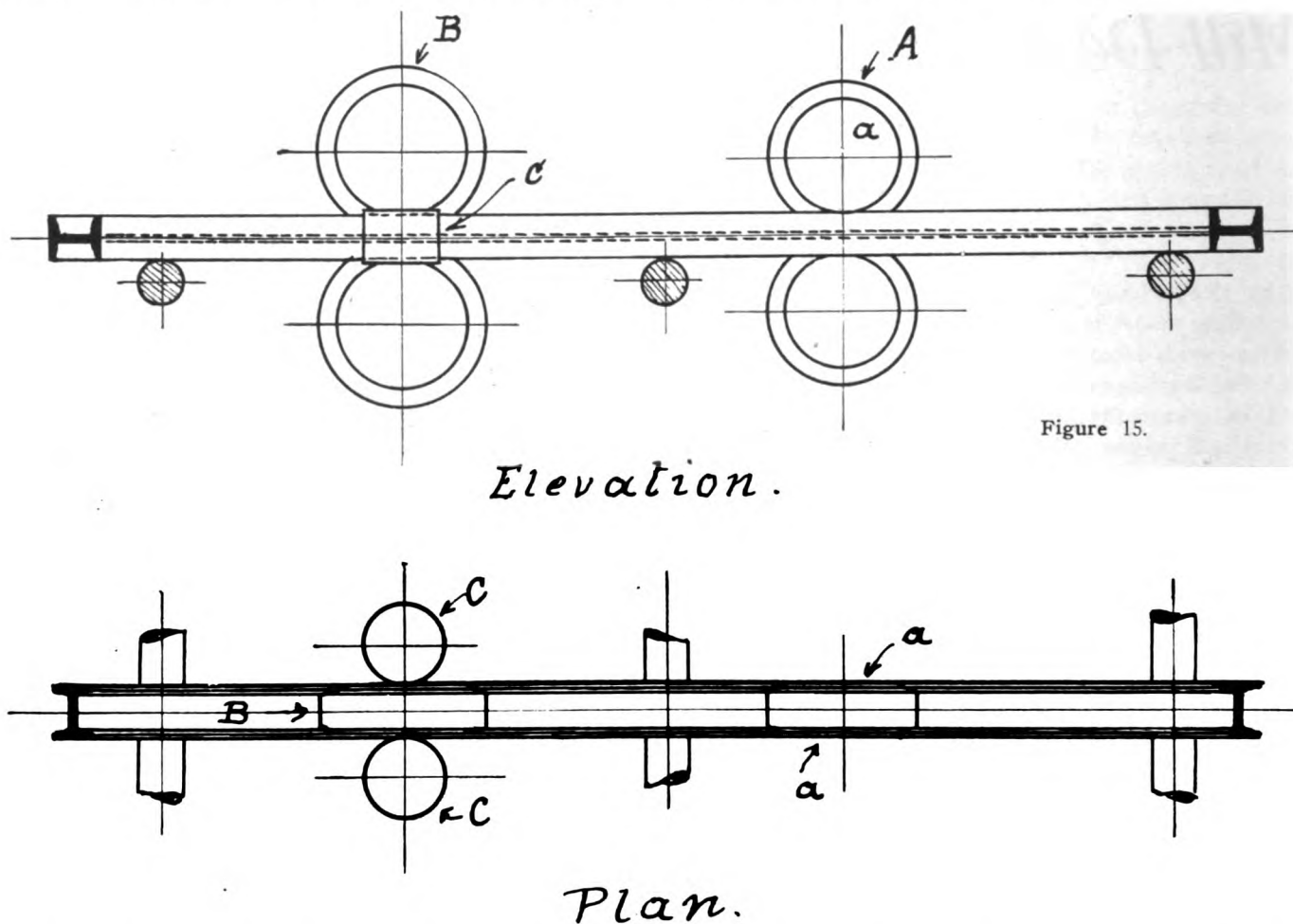


Figure 15.

which may be moved all at the same time or as many at a time as is necessary.

The objection may be made against this type of a mill, that the two stands "A" and "B" (fig. 15) are located too closely together, therefore causing either a stretching or a bending sideways of the beams. But this objection can be overcome as may be seen from the following reasoning.

The work done in the auxiliary rolls "A" does not require very much pressure which, however, is exerted to a large degree in the universal mill; thus, a pulling or bending is practically avoided. But in case there should actually occur a little pressure or tension in the beam between the corresponding roll stands this does not hurt the beam the latter being in a red hot

of rolls, the sections may be varied in regard to size and weight, thus enabling the designer to select the proper areas to suit the variations of load.

The sizes rolled in the Differdingen Grey mill vary between 7 in. x 7 in. and 12 in. x 12 in. H-beams. From the latter size on, the width of the flanges remains constant and equal to 12 in., while the height increases to 30 in., the largest size being rolled being 30 in. x 12 in. The sloping of the inner side of the flanges amount to 9 per cent. (These figures are taken from the 1911 issue of the "Huetten").

After the mill had been in successful operation for several years, the Bethlehem Steel Company decided to erect one of the same type at its plant at South Bethlehem, Pa. Rolling was started early in 1908, and

also proved successful. The experiments made in Differdingen have been used for the design of this new mill, which differs in several ways from the first Grey mill.

At Differdingen the beams are rolled down after having left the blooming mill and the reheater from a rough H-shape to the finished section in one mill,

the Bethlehem Steel plant, designed to be of about the same size as the one at Differdingen, i.e. a 40 in. bloomer and 42 in. Grey mill. The completion of this mill has been delayed to a certain extent because the present mill has been rebuilt to suit modern present-day conditions.

The shapes rolled in South Bethlehem vary be-

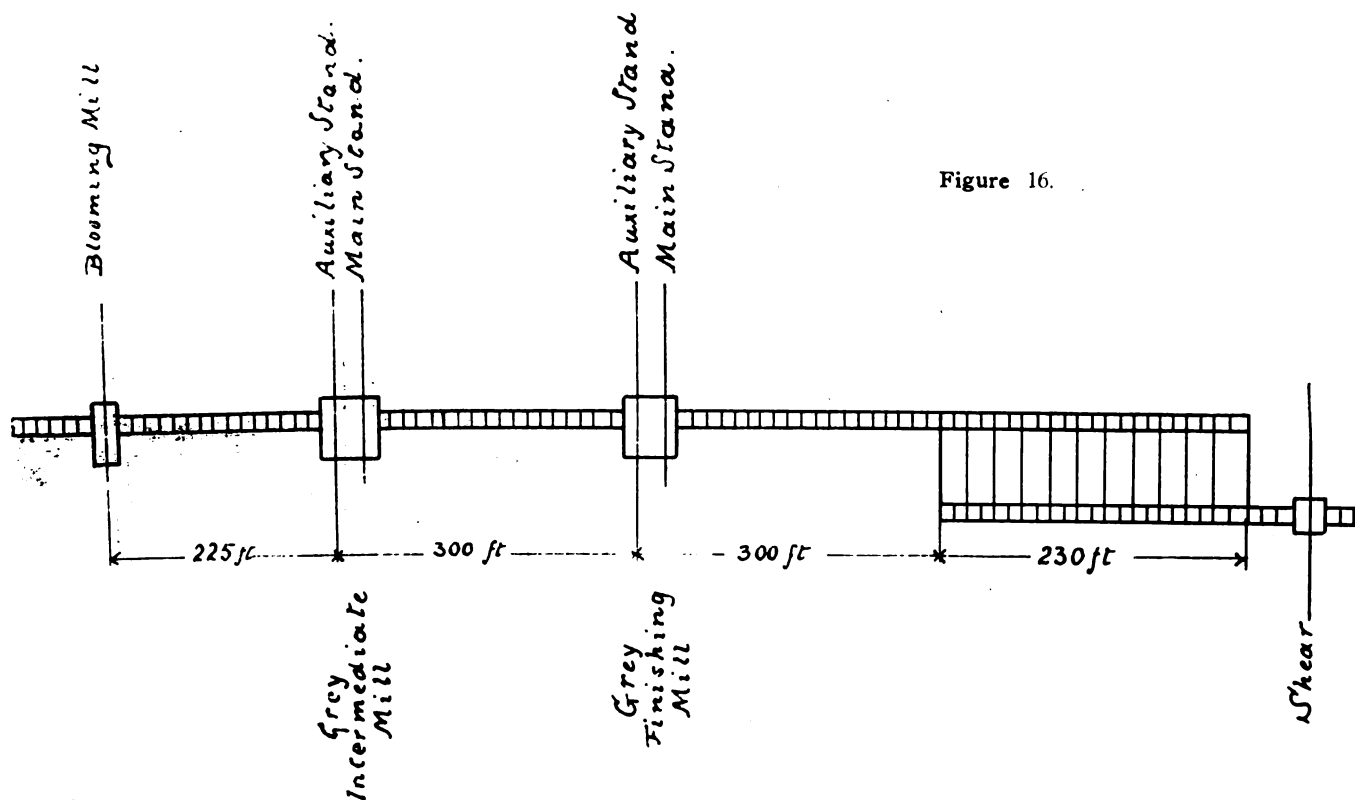


Figure 16.

consisting, as was shown, of one stand of auxiliary rolls and one stand of main rolls. At South Bethlehem, two such Grey mills of the same size and design are used for the purpose, the first mill being an intermediate mill and the second one the finishing mill. This insures a larger output. Besides, the mills are built heavier than the Grey mill at Differdingen. A plan of the general arrangement of the mill is shown in fig. 16., illustrating the location of the roughing mill and the two Grey mills.

Between the first and the second Grey mill there is a roller table of somewhat over 300 ft. in length. This is necessary, in order to be able to roll small sections in one mill in the direction towards the other one.

The rolling is done in nearly the same way as at Differdingen, with the exception that at South Bethlehem the ingot is in the first mill into which it enters through the auxiliary rolls not rolled down to its final section. This is done in the second mill. The size of the mill is larger than the size of the old one the blooming mill having (nominally) 46 in., and the two Grey mills (also nominally) 48 in.

The erection of a new Grey mill is under way at

tween 8 in. x 8 in. and 14 in. x 14 in.; besides these H-sections, girder beams and standard sections are rolled also. The flanges of the I-beams and the girder beams have a uniform slope of 9 per cent while the flanges of the H-sections have a uniform slope of 2 per cent. The latter means a decided advantage over the Differdingen H-sections with a slope of 9 per cent. The reasons for this will be explained later.

As was stated above, with a universal mill a large variety of sections can be rolled with one set of rolls. For instance, Bethlehem H-14 varies from 13¾ in. x 13.92 in. to 16⅞ in. x 14.9 in., comprising 26 different sections. The corresponding areas are 24.46 sq. in. and 84.5 sq. in. respectively and the corresponding weights 83.5 lbs./ft. and 287.5 lbs./ft. For H-8 the corresponding figures are 7⅞ in. x 8 in.; 9.17 sq. in.; 32 lbs./ft., and 9½ in. x 8.47 in.; 26.64 sq. in.; 90.5 lbs./ft. respectively, comprising 14 variations. A large selection is, therefore, possible to suit the structural conditions. It has, for instance, been claimed, that all columns necessary for a 14 story building can be rolled with the same set of rolls, without changing the

(Continued on Page 68)

Equipping Plant for Heavy Steel Work

Equipment Lay-Out for Handling Heavy Stock Through Plant Without Hand Labor—Combining Overhead, Wall Gantry and Jib Cranes for Economical Lifting.

By CHARLES C. LYNDE.

Designed to give straight-line forwarding of the work from the standard gauge receiving track at one end of the plant to the hydraulic testing rack at the other, the new Wheatland plant of the Knox Pressed & Welded Steel Company is an excellent illustration of the way in which production planning may be

the handling of stock into box cars, as well as reducing the trouble of getting into and from gondolas. The span of the building at the tracks is sufficient to cover and permit to be enclosed two freight cars at each end, while track facilities outside the building give storage space for several more.



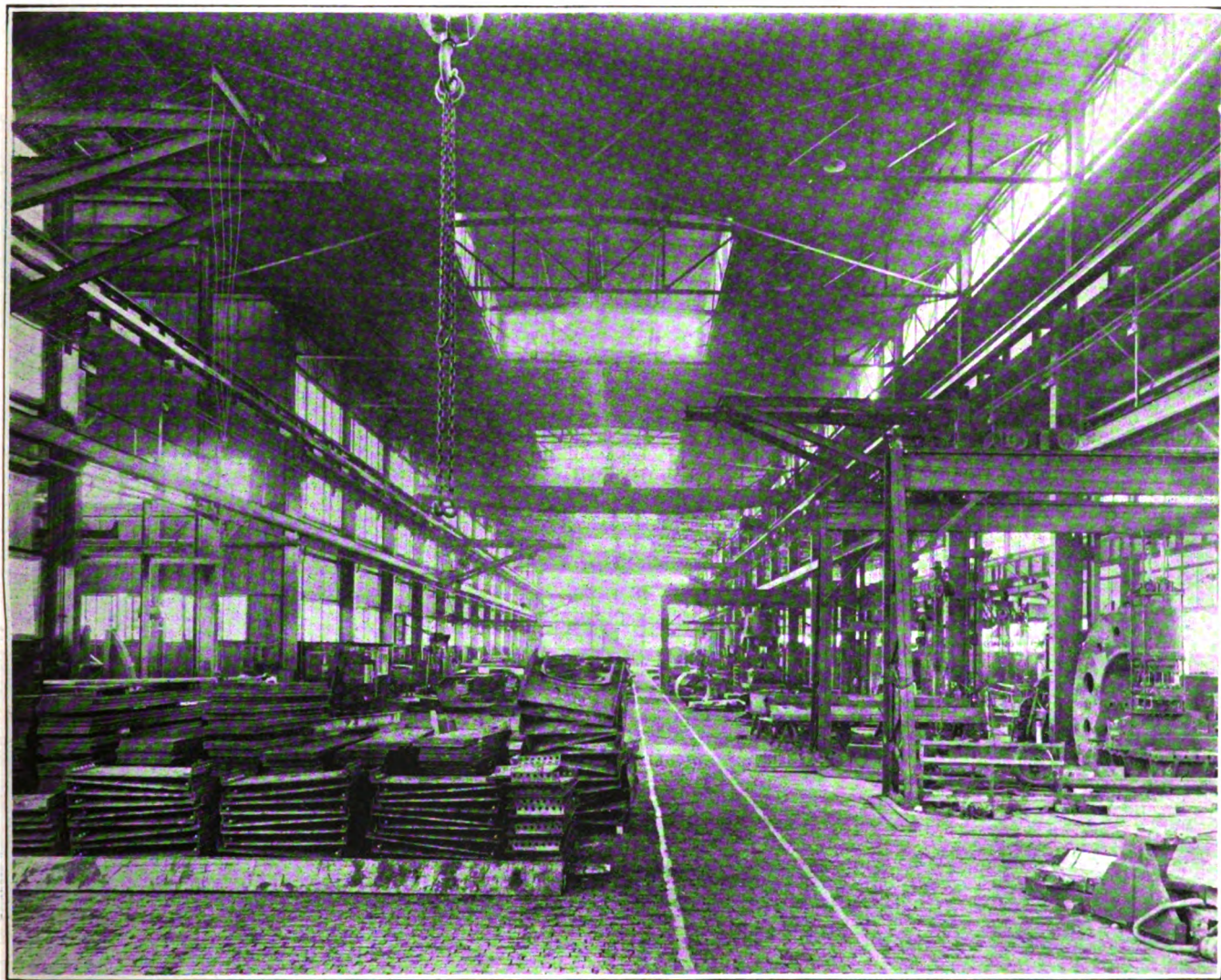
View in main bay showing special handling equipment for heavy press.

carried out to save rehandling of materials; and it is also, incidentally, about as completely equipped with crane service for handling these materials as any plant in which the writer has been. Depressed tracks, located four feet below the general floor level, are used for both incoming and outgoing tracks, putting the material at approximately floor level and simplifying

Crane service installed in the main building, which is 114 feet by 500 feet, consists of three 15-ton traveling cranes, six wall gantries and jib cranes on a majority of the side members of the building. The three overhead cranes are handled in the customary way, an operator being stationed in the cab of each. Floor control is provided on the wall gantries, while the

electric hoists on the pillar jibs are also pull-controlled. All crane pulls come to a standard height from the plant floor, and are equipped with safety devices so that a runaway crane is an impossibility. With the crane and other hoist service provided there is almost no hand lifting of any bulky material, and there need not be space left for the industrial track usually found in a shop working on heavy sheet material. Instead of the track a wide aisle is maintained down the main shop—70 feet in the clear and 35 feet to crane rails—as is shown by the two wide white lines

sheet and tin mill specialties, such as open hearth doors and door frames, skewbacks, buckstays, wall and arch coolers, floor standings and shields to acid tanks, gear guards and annealing covers—calls for special heavy equipment, including a 600-ton hydraulic press and two smaller ones, of 100 and 200-tons capacity, respectively. The main casting of the big press weighed, when finished, something over 80 tons, and required a special railway car for its transportation. When it came time to set up the massive casting in the Knox plant it was necessary to



White paint marks the aisle through the plant—and the marks must be observed.

appearing in one of the plant views reproduced herewith. This aisle is kept clear under all circumstances, penalty of dismissal from the company's employ attaching to anyone found guilty of infringing upon the borders set. The flooring is of vitrified brick, to withstand the heavy service exacted of it, save in the hydraulic testing department, where a concrete catch basin is provided to impound the water used in testing.

The nature of the products made in the Knox plant—ranging from the Knox line of open hearth and

run two lines of railway, standard gauge, through the shop, and to call in the services of two railroad wrecking cranes to unload the frame and put it in place.

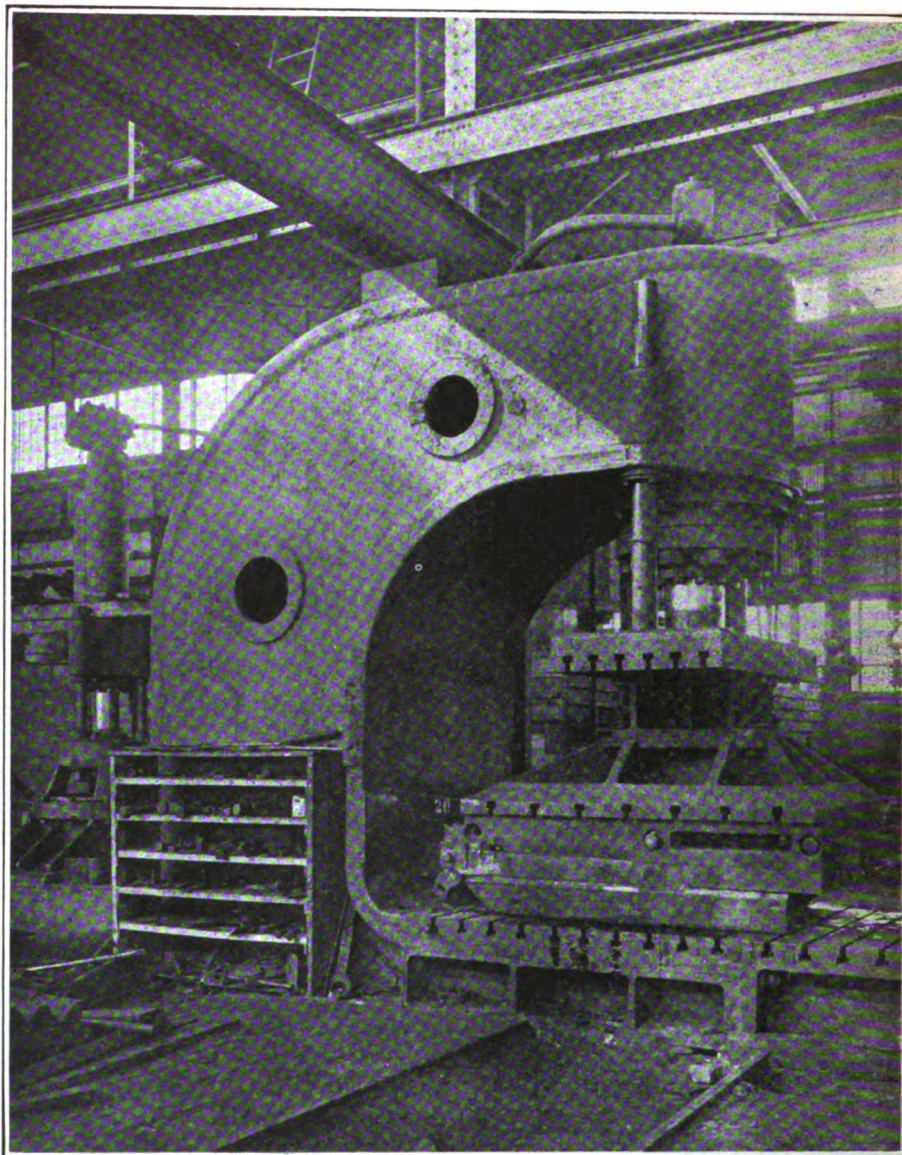
Other hydraulic equipment includes two riveters of six- and eight-foot gap; punching machines, including one with capacity to punch a six-inch hole in one-inch plate, 72 inches in from the edge. There are also the usual machine tools, portable drills, and other equipment used for heavy plate work.

Welding plays an important part in the finished product, and is done in any of the three ways in this

plant. There is a complete equipment for oxy-acetylene welding, with a number of leads for acetylene piped through the shop to give a wide distribution of the gas. The oxygen used is obtained in tanks, a tank being set up for each welding outfit. The oxy-acetylene flame is used for cutting out the irregular outlines required on some of the special products turned out, and for this work is unequalled. Electric welding is sometimes found to be the most advantageous, in which case the work is arc-welded. For this work a part of the 46-foot bay flanking the main portion of the shop is fenced off with corrugated iron, making a light and glare-proof wall to protect the eyes of the other workmen in the shop from the baneful effects of the unprotected arc. The welders themselves wear a special welding head-gear, and are shielded in this way. Hammer or percussive welding is also sometimes employed—the choice of the method depending largely upon the service expected of the product, and the convenience of carrying out the welding. When hammer welding is used, as on such work as the top seam of an annealing box, a portable narrow-gauge track is laid along under the two formed sections to be joined, and a small coke furnace run along on this track, the opening at the top of the furnace being close to the matched edge. In this way the metal is brought to the required temperature, after which a heavy steel dolly, carried on a small air ram, also mounted on a truck fitting the narrow-gauge railway, is run along under the seam, and the beveled edges filled with a filler rod while a hammer is used above the seam to close the weld. The use of the portable furnace and dolly shortens the operation time on such work considerably over that required when special set-ups must be made every few inches of the weld.

After the welding and other forming work is completed the piece is taken back to the testing stand, and there hydraulically tested under pressures greater than it will be called upon to withstand in service. If found O. K. the parts may then be carried one step farther through the shop and loaded onto a waiting car for shipment—having traversed the plant but once, and, if, of appreciable bulk, having been crane transported throughout its journey.

Individual motor drives are used on all power equipment in the main section of the plant, for better control and to keep everything down out of the radius of crane action. In the bay where the machine tools are located a countershaft drive is used, as no crane service is here required. These countershafts are also



View of 600-ton press and auxiliary equipment.

motor-driven, there being no steam generated on the premises. All power is purchased from a central station source, and motor-driven air compressors and pressure pumps used for powering the air and hydraulic tools. The special transverse craneway for handling material to the 600-ton press is built as low as possible to allow free crane room overhead, and the cranes used to serve the press are run within the framework of the support, to give additional protection to these units from loads overhead. Two units are provided on this runway, to permit of a standby in case of breakdown, or to give one crane for handling work to the press and the second for removing it.

The entire plant is lighted with 500 k.w. incandescent lights, placed as high as practicable, and equipped with porcelain reflectors. In the main bay the lights are forty-two feet above the floor. The result is a clear light over the entire plant, no shadows, and the absence of dazzling spots of light at a level low enough to interfere with the workmen's sight. The roof, roof framing and side walls are all painted white, and the entire plant is free from shadowy corners, even on a dark day.

An emergency hospital has been fitted up in one corner of the plant, with all necessary first-aid appliances. Goggles must be worn by chippers and others exposed to flying steel, as well as by the welders

using oxy-acetylene or the electric arc, and every precaution is taken to keep conditions as safe as possible.

A dining and locker room is being equipped, to give lunching and rest facilities to three hundred men, and is located adjacent to the time office and entrance into the plant.

A works office is set up near the plant, from where the shop management and design are supervised; though the sales and executive offices of the company are located in the Farmers National Bank building, Pittsburgh, Pa. Officers of the company are: L. L. Knox, president; W. C. Coffin, vice president; Irwin F. Lehman, secretary and treasurer.

Calculations Covering Carbon in Furnaces

Discussing Paper by H. P. Howland, Appearing in These Columns in May, 1916, With Diagrammatic Summarization of Carbon Per Ton of Iron as Distributed.

By J. W. RICHARDS.

Mr. Howland's paper, data and conclusions have interested me intensely, and have led me to study carefully the record of his 26 furnaces therein given.

Mr. Howland is undoubtedly right in his conclusion that when expressing the amount of carbon burned at the tuyeres in percentage of the total carbon gasified in the furnace, there is no apparent relation between this percentage and the fuel consumption of the furnace. In the diagram accompanying this discussion the broken line represents the complement of this percentage; that is, the percentage of the carbon gasified which is gasified above the tuyeres, or the difference between Mr. Howland's percentages and 100. The irregular character of this percentage is at once evident, showing that there is no simple relation between the percentage of carbon gasified above the tuyeres and the fuel consumption of the furnaces. It proves conclusively that Gruner's law does not apply either directly or inversely to the working of the blast furnace when the amount of barbon burned at the tuyeres and gasified above the tuyeres is expressed in percentage of the total carbon gasified in the furnace. On this base, therefore, and with this manner of expression, Gruner's ideal working is proved to be neither right nor wrong, but simply no guide at all to the question of fuel efficiency in the furnace.

After contemplating for some time this knockdown for a very much discussed theory, the writer was led to plot diagrammatically Mr. Howland's 26 furnaces, and the accompanying diagram shows the amount of fuel charged, the carbon charged, the carbon gasified in the furnace, the carbon gasified at the tuyeres and the carbon gasified above the tuyeres (+1,000 in order to

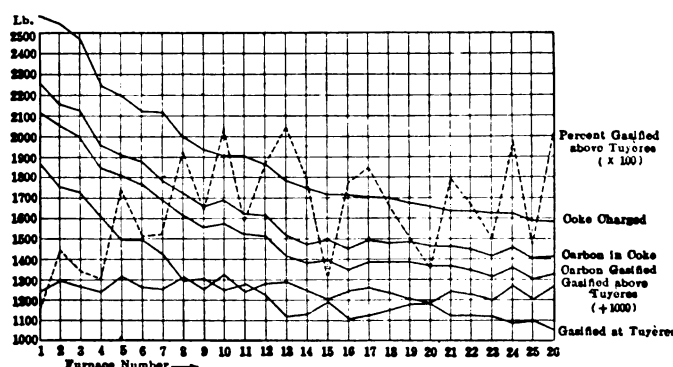
get it on the diagram), all expressed in pounds of carbon per ton of iron made.

The conclusion to be drawn from this diagram is evident at a glance. While the carbon gasified at the tuyeres varies from 1,868 down to 1,057 pounds, a variation of 811 pounds per ton of iron made, the line representing carbon gasified above the tuyeres, in pounds per ton of iron made, is nearly horizontal, the maximum variation being from 323 to 184, or 129 pounds. Of course, if these variations were expressed in percentages of the carbon gasified above the tuyeres, they would be enormous; but such an expression is without significance, just as expressing them in percentage of the total carbon gasified appears to be without significance. The really significant fact is, that in these 26 furnaces with a variation in carbon gasified at the tuyeres of 811 pounds, the variation in carbon gasified above the tuyeres is only 129 pounds, that is, the latter item is relatively constant in amount, when expressed per ton of iron made.

Furthermore, the variation in pounds of carbon gasified above the tuyeres does not coincide with the variations in amount of fuel used in the furnace, but, as inspection of the lines on the diagram shows, is a wavy line about as high at one end as at the other, having its maximum at furnace No. 20, but with no observable regularities in rise or fall paralleling even remotely the consumption of fuel in the furnace. It is very evident that Mr. Howland's figures prove that the amount of carbon gasified above the tuyeres, expressed in pounds per ton of iron made, is practically constant in all his 26 furnaces, averaging 250 pounds per ton of iron, and that it is unrelated to and inde-

pendent of the total fuel consumption of the furnace.

A further conclusion from this diagram is that the amount of carbon gasified at the tuyeres is closely parallel to the amount of carbon charged into the furnace. We therefore arrive at the comparatively simple view that in all these 26 furnaces, varying immensely in fuel consumption, the weight of carbon gasified above the tuyeres is practically constant, while the weight of carbon gasified at the tuyeres is practically a function of the total weight of carbon charged; that is, it is necessarily the total carbon gasified minus the relatively constant amount gasified above the tuyeres. We therefore have before us the consideration of a constant factor in the fuel consumption, namely, the constant weight dissolved or gasified above the tuyeres; and the variable amount burned at the tuyeres is simply proportional to the variable



amount of carbon charged minus the above-mentioned constant.

This statement would require that the percentage of carbon gasified above the tuyeres would decrease as the total amount of fuel consumed increased, or would increase as the weight of fuel charged per ton of iron decreased. This is the reverse of Gruner's ideal working, yet it is borne out in a roughly approximate way by furnaces 1 to 10 where the fuel consumption drops rapidly from 2,615 to 1,905 pounds and the percentage of carbon gasified above the tuyeres increases rapidly from 11.4 to 20.5. In furnaces 10 to 26, in which the fuel consumption still further decreases, but slowly, no such regularity, even approximate, can be observed; there is practically no observable relation between fuel consumption and this percentage. It would appear from the above discussion that expressing the amounts of carbon gasified at the tuyeres and gasified above the tuyeres, in percentages of the total carbon gasified in the furnace is a useless and misleading operation, and that no definite conclusions of value can be attained by doing it. On the other hand, for furnaces working under approximately similar conditions of ore, fuel, etc., if these amounts are kept in pounds or kilograms per ton of iron made, a very simple relation appears; namely, that the weight of carbon gasified above the tuyeres is practically constant, while the weight of carbon gasified at the tuyeres varies in paral-

lel with the total carbon gasified in the furnace, that is, approximately with the fuel consumption.

From an inspection of Mr. Howland's data, the amount of carbon gasified above the tuyeres in his 26 furnaces does not appear to vary with size of the furnace or the amount of pig iron made per day or with the kind of coke used. It appears to be a practically constant amount for the whole 26 furnaces, and independent of any of the detailed conditions of operation scheduled by Mr. Howland. It is possible that furnaces run with different kinds of ore of different sizes and with entirely different fuel, such as charcoal, would show greater variations in the amount of carbon dissolved or gasified above the tuyeres. Such a comparison would be instructive and bring out the factors which really control the solution of carbon above the tuyeres. Such a study is much needed to throw further light upon this interesting discussion of blast-furnace phenomena. But, as far as we have gone, we can say that Mr. Howland's splendid paper has proved this one important and illuminating point, viz.: that the solution or gasification of carbon above the tuyeres is independent of the fuel consumption, is practically a constant amount in weight per ton of iron made, and does not condition or determine the fuel efficiency of the furnace in usual furnace practice.

Mill Design for Rolling Flat-flanged Beams.

(Continued from Page 63)

main horizontal rolls and without turning while work-

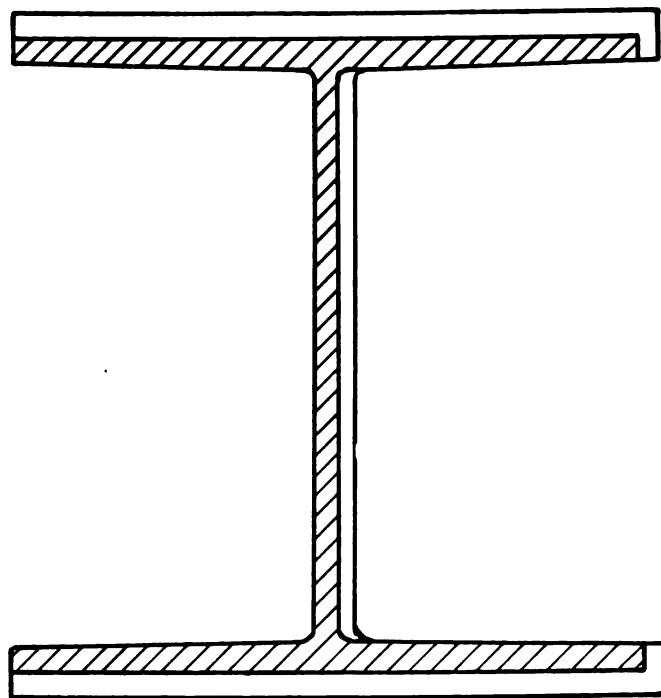


Fig. 17.

ing in the blooming mill, notwithstanding the fact, that the load varies between 350 tons in the base-

ment and 33 tons in the 14th story. It is however questionable if this "advantage" is really an advantage from the standpoint of the designer or from an economic standpoint.

Fig. 17 shows the way in which the variations of

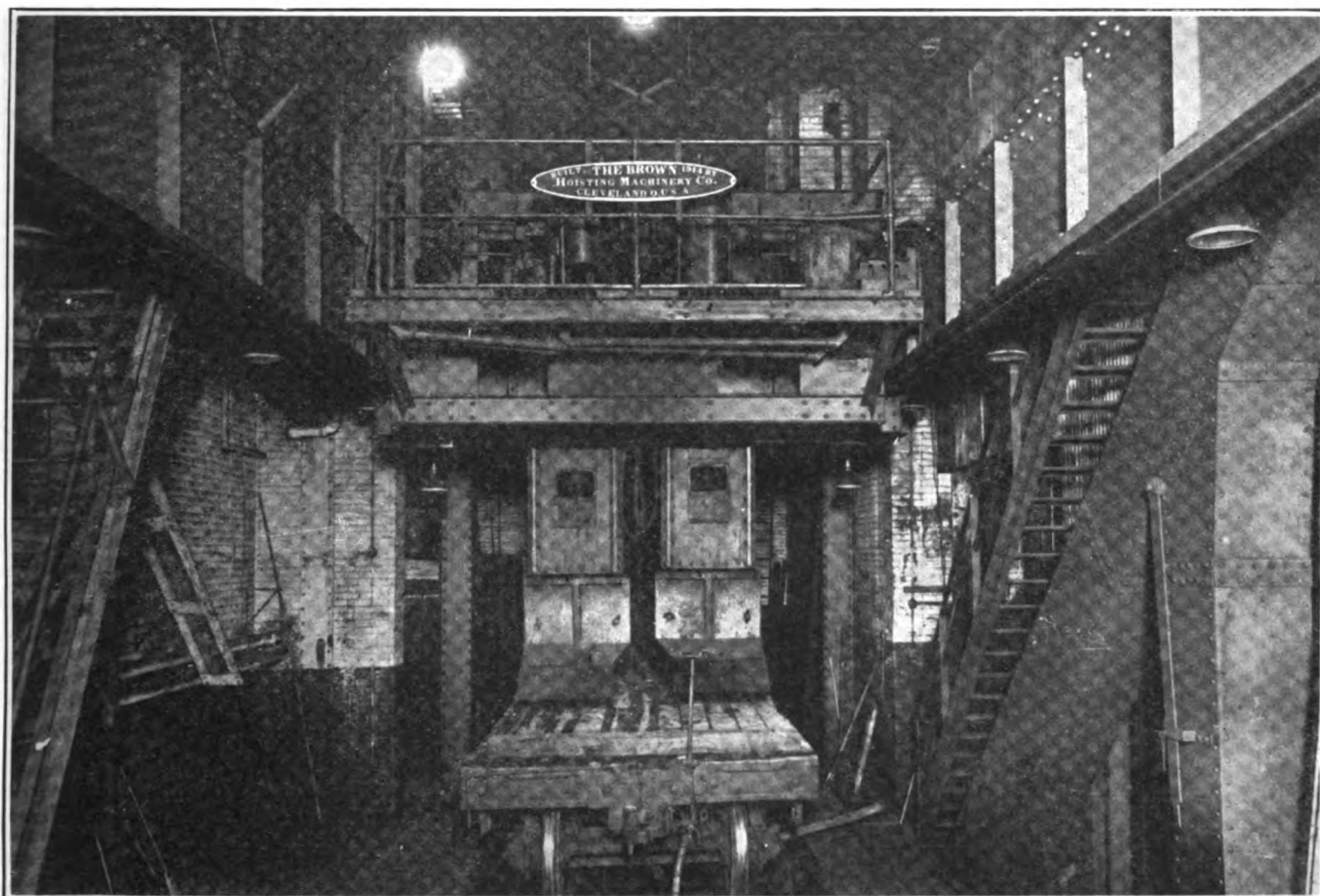
H-columns are rolled. The increase is made by spreading both sets of rolls. The thickness of the web and the width of the flanges are increased equally, while the thickness of the flanges is increased a proportionate amount.

Unloader for Frozen Ore and Coal Cars

Power Appliance Developed to Give Easy Unloading of Frozen Freight Without Damage to Car and With no Loss of Time.
Hopper-Bottom Cars Unloaded in Few Minutes.

This machine was designed primarily for unloading cars in which the coal had frozen. But it has proven to be a very useful machine at any time of the year as it unloads a 50 ton coal car in 5 to 6 minutes forcing the coal into the trackhopper and is equally

received by this company during the winter season, the coal is frozen at the top and bottom of the car for a distance of about two feet, and often throughout the entire depth of the car. In either case the coal would not flow from the car when the hopper doors



Unloader, showing spuds for breaking out solidified ore or coal from the bottom of a car without requiring laborious work.

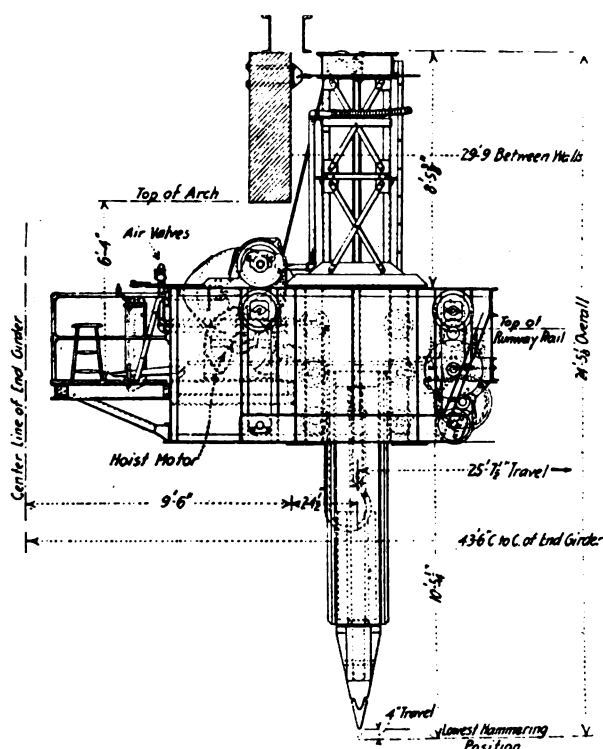
useful for unloading. The origin of the machine makes an interesting story.

The Edison Illuminating Company of Detroit, had for many years experienced considerable difficulty in unloading a sufficient amount of coal to meet the load demand at its power houses during the winter season when the coal had become frozen in the cars. As

were opened and it would be necessary to force an opening by drive a small pipe with a hand hammer through the frozen coal at several places. This operation required from 30 to 90 min. After an opening had been made the coal was loosened by picks. The whole work of unloading a car would require from 1½ to 4 hrs. depending upon the degree to which the

contents were frozen. To get around this time loss, J. P. Considine, engineer with the Edison Company, planned and patented the machine as shown here, for speeding up this unloading.

The coal breaker and scraper consists of a carriage supported by, and traveling longitudinally on a girder runway, and two spuds with air hammers carried by the carriage. The carriage, weighing 15 tons, is held in position by four doubled-flanged wheels which run on the top of the runway girders, and is driven by a 22 horsepower, variable-speed motor through pinions that mesh into racks fastened to the bottom of the girders: another method for propelling the machine along the runway is by cables dead ended at each end of the runway and connected to the traveling motors on the machine. Either of these arrangements affords



Sketch showing unloader parts.

a positive drive that does not depend upon the tractive effort of the flanged wheels. The travel motor is provided with a solenoid brake for promptly arresting the high speed parts of the mechanism when the current is shut off. A limit device is also provided for the travel mechanism, to prevent running off the runways. The carriage carries two spuds, each weighing $4\frac{1}{2}$ tons and each cable suspended from the electric hoisting gear.

In the spud above the anvil block there is a double acting hammer weighing 3,400 pounds to which is connected a flexible air hose. The two spuds occupy approximately the full width of the car. One or both may be operated at a time, being raised by one 52 horsepower variable speed motor. The hoist motor

is provided with a solenoid brake, and there is a limit device to prevent overhoisting.

In fig. 1 the spuds are shown lowered to a position at which the elevation of the lower ends corresponds to the height of the car floor. When the machine is not operating the spuds are carried at the highest position, the lowest extremity being on a line with the bottom of the carriage.

As shown in Fig. 1 the bottoms of the spuds are cut out at the inner side, thus allowing them to clear the center beam on hopper bottom cars. A small portion of the coal escapes through the opening between the spuds but this is negligible in amount and can be removed quickly with shovels. Fig. 2 shows the construction a little more plainly than the photograph.

When a car is to be unloaded it is placed over the hopper and the doors dropped. If necessary as in the case of frozen coal, the spuds on the machine can start the coal flowing through the doors. The machine is run to one end of the car and the spuds lowered into the coal and then the machine is run forward scraping the coal towards the doors and dropping it into the hoppers. This is repeated on the other end. As stated before it requires from 5 to 6 minutes to clean the car.

The machine was first put to work in May 1914 and has been in continuous operation since then. The machine is manufactured and sold by The Brown Hoisting Machinery Company, Cleveland, Ohio.

Definition of Hardness.

By A. E. H. TUTTON.

The hardness of a solid substance may be defined as the resistance offered by a smooth surface of the substance to abrasion. It is measured by the capability of the substance being just abraded or scratched by contact with a sharp fragment of another substance of slightly greater hardness, and of which the precise degree of hardness is known with reference to a conventional scale. Particles of the softer substance are torn away by the harder, their cohesion being overcome. Hence, hardness is intimately connected with cohesion. If the solid substance is crystallized, the hardness varies slightly with the direction within the crystal, as cohesion in a crystal is in general dissimilar in different directions; thus hardness is always lower along a direction of cleavage than along the direction perpendicular thereto. For cleavage planes are planes of points of the crystal space-lattice which are most densely strewn with points, and in which cohesion is, therefore, a maximum, while successive parallel planes of points (all parallel to the plane of cleavage) are the most widely separated from each other, the points being farthest apart in the direction at right angles to these planes; the cohesion is, therefore, minimum perpendicular to the plane of cleavage. The particles

are, consequently, more readily torn off from a cleavage face than from any other face of a crystal. Moreover, high specific gravity (density) is generally accompanied by great hardness. For (considering the case of the perfect solid—a crystal), the points of the space-

lattice being the closer together the denser the substance, greater difficulty is naturally experienced in overcoming their cohesion, in accordance with the usual laws governing the attractive forces between particles.

Electric Skip Hoists for Blast Furnace Use

Design Characteristics of A.C. and D.C. Motors When Used for Skip Control — Obtaining Accurate Slow-Down and Stop Without Adding Excessive Apparatus to Installation.

By H. D. JAMES.

The electric skip hoist is a specialized application representing one principal problem, which is the automatic slow-down and stop of the skip at the proper point of its travel. This problem is complicated, as in most skip hoists the bucket travels over a knuckle at the top of the runway in order to empty the contents of the skip automatically onto the little bell. As the skip passes over the knuckle the torque on the motor changes from a positive to a negative value. It is possible in many cases that the torque is not very great, but there always exists a tendency to speed up when it is most desirable to slow down. There are a number of special arrangements of skip hoists which differ somewhat from the above, but I believe that I am safe in saying that most of the applications at present are as outlined above.

The method commonly used in slowing down d.c. motors consists in placing a shunt around the armature and resistance in series with the armature. I shall speak of this as a combination armature shunt and series resistance arrangement. Sometimes a motor is used having an extra winding in the field, giving a 100 per cent field strength increase. Such a motor is equivalent to a 2-1 adjustable speed motor and will serve to give a positive speed approximately half the normal speed. This speed adjustment may be carried out to a 5-1 reduction, but the motor soon becomes too large to be commercial. By using an armature series and shunt resistance a satisfactory slow-down has been secured without manipulating the motor field.

When a motor operates full speed and connected to full line voltage without external resistance, the speed remains practically constant under all conditions of loading. Now, if we are operating the motor at 300 feet per minute and insert all the armature series resistance and shunt the armature with the maximum amount of shunt resistance the current will have a negative value of 700 amperes, and the torque will be of a negative value corresponding to that current. It is assumed that the positive load on this mo-

tor requires 825 amperes. If the motor is still under positive load the speed will immediately slow down to an assumed speed of 50 feet per minute, which corresponds about to 850 amperes armature current. The current in the power lines increases from about 200 amperes to 1,050 amperes at 50-foot car speed.

If we now short-circuit part of the resistance in the shunt to the armature the current will drop momentarily to a positive value of 500 amperes and increase to 825 amperes at 20-foot car speed. The current taken from the line will now increase to about 1,150 amperes. Assuming that at this point the skip commences to empty, the torque on the motor decreases to a small negative value and the speed tends to increase to over 100 feet per minute. Owing to the inertia of the moving parts and the short time interval before the controller reaches the "off" position, the speed probably will not exceed 50 or 60 feet before the circuit is broken and brakes applied.

Using the scheme outlined above an intermediate slow-down speed is required. If this were omitted the current would tend to have a very high negative value during change. Better results could be obtained with three slow-down speeds, but sufficient torque must be kept to carry the skip over the knuckle.

Various schemes have been devised for adjusting the armature shunt resistance automatically, so as to give a fixed slow-down speed. As the time between passing the knuckle and stopping is very short, the inherent time element of automatic devices makes advisable the use of series devices instead of shunt as quicker action can thus be secured.

Skip hoists have been operating successfully using fixed amounts of armature shunt resistance and controlling these by the skip travel. This is very simple and satisfactory. Adding a third step would give a closer stop, but where a leeway of an inch or two is permitted is not necessary.

The amount of current taken from the line during the slow-down period is one of the chief arguments for using a motor having an adjustable field strength.

In passing from the high speed to the slow speed winding on an a.c. motor, an intermediate step is not

Abstract of paper presented before the Association of Iron and Steel Electrical Engineers.

necessary. The load on the motor will be positive and the negative torque will be less than full load torque, and will gradually increase to its full load value without shock or jar to the machinery.

The slow speed required for making an accurate stop is one of the debatable points in skip hoists. The writer believes that the use of an induction motor with a positive value for the slow-down speed will give a higher value for this speed that is commonly used for d.c. motors.

To summarize the advantages of the a.c. motor, they are:

First—The use of a.c. power without converting it to d.c.

Second—A fixed slow speed, practically independent of the load.

Third—Inherent characteristics of the motor which enable a change to be made from the high to the low speed without jar or shock, simply by changing the primary connections of the motor.

Fourth—Increasing efficiency during the period of slow-down.

Potash as a Blast Furnace By--Product

Outlining the Possibilities of a New Field for Blast Furnace Savings, in the Saving of Potash and Derivatives — Occurrence and Nature of Deposits Within Furnace.

By R. J. WYSOR.

Since the outbreak of the European war, few problems of raw-material supply have commanded more nation-wide attention than potash. It is well known that before the war the domestic production of potash was an insignificant percentage of the imports. The average annual importation of raw potash salts for several years prior to 1914 was slightly over 300,000 net tons, and of other potash manure salts about 700,000 tons. The sudden and almost total cessation of these imports created a unique and stringent situation. Methods of recovering potash from feldspar and other native mineral sources, and reclamation from hitherto waste products, have received a marked impetus. Soaring prices have been a keen incentive to research and industrial development.

Although several brief articles concerning the possibilities of potash recovery have appeared in recent trade journals, it still may be a matter of some surprise to the average technical mind that potash might be reclaimed as a profitable by-product in the manufacture of pig iron. At the present time it may be of special interest to present some data, largely of a technical nature, on this subject.

A fairly thorough search of the literature reveals a number of articles concerning salts of the alkali metals in the blast furnace. Many of them deal with the theoretical role of alkali cyanides in the furnace. Several discuss the probable effect of the alkalies on the furnace brickwork. Two or three ambitious patents have been granted for reclaiming potash or other products from blast-furnace gas. However, we have heard nothing further as to the practical application of these patents. Little literature of importance has appeared during the last 10 years concerning alkalies in blast-furnace practice, and I have discovered no record

whatsoever as to the actual sale or commercial disposal of flue dust for its potash content until this was inaugurated in our plant at Bethlehem.

About 4 years ago, in the cause of investigating blast-furnace stove efficiencies, I analyzed the fine, yellowish fume of which a considerable quantity was removed from the bottom of the stove checkerwork. The sample was found to contain, among other constituents, about 15 per cent water-soluble potash, which was somewhat surprising. This induced an investigation, which showed that considerable quantities of this material, hitherto a waste product, could be recovered from our stove and gas-fired boiler settings. A search for a market was made without immediately satisfactory results. One fertilizer dealer claimed that the alumina content was too high. Others wished to make practical tests, and we furnished large samples for a full season's demonstration, satisfactory results being reported. But the pre-war-time prices offered hardly seemed to justify the trouble of reclaiming the dust.

With the beginning of the war and the subsequent spectacular rise in the potash market, conditions were changed. Knowing just what dust to recover, reclamation was immediately commenced, a satisfactory contract was negotiated, and this company has been disposing of the dust at a good profit ever since.

Having introduced the subject thus far in the same order in which it was initially investigated, we may now turn logically to an inquiry as to the source of potash in the raw materials charged, behavior in the furnace, and methods for recovering it as a by-product, or of eliminating it as a nuisance. As a matter of both scientific and practical interest, a consideration of sodium will also be attempted, though not so thoroughly as its more important kindred metal, potassium.

First portion of paper for the February meeting American Institute of Mining Engineers.

Occurrence of Alkalies in Raw Materials.

Potash doubtless occurs almost entirely in some form of feldspar or clay in all the materials entering the blast furnace.

At Bethlehem we receive ores from many quarters of the globe, and an attempt was made to discover whether the relative percentages of alkalies in the various ores bear any special relation to the source, mineralogical nature, or to the silica and alumina contents of these ores. No striking relation was discovered, except that the manganese ores, from widely separated sources, were found to contain relatively high percentages of potash as compared to most iron ores. Iron ores of this country, including those of the South, containing upward of 1 per cent potash, or over, seem to be restricted to small areas.

The percentage of potash in different varieties of limestone and dolomite used as flux, varies greatly, largely on account of intermixed clay, and may be surprisingly high. Per unit weight, the potash content of our flux charge at Bethlehem is considerably higher than either the average ore or coke charge.

Few data are available on the alkali content of coke

from different localities. Various standard Connells-ville cokes which we have examined have shown a much lower alkali content than our local by-product coke made from West Virginia coals.

It may be a matter of some surprise to note that, with one exception, the soda contents of all the iron ores, the coke and the flux, subsequently listed, are much higher than the potash contents.

Before presenting any analyses, it may be mentioned that the difficult analytical determinations of potash and soda, and the complete analyses of the various miscellaneous samples, were executed almost entirely by two expert analysts, who literally spent several weeks in this work. Most of the determinations were duplicated to insure their accuracy.

(To be continued.)

The February meeting of the Pittsburgh section, Association of Iron and Electrical Engineers, will be held at the Fort Pitt Hotel on Saturday, February 17, under the auspices of the Safety Committee, H. A. Schultz, chairman. The 8:00 presentation of papers will be preceded by a dinner at 6:30.

EDITORIAL

Is the Bonus Good?

DICTIONARIES and other philological authorities assure us that our word bonus is taken direct from the Latin word of the same spelling, meaning good, and the ancient meaning is usually accepted in our use of the word. The word has been given unusual prominence during the past few months, through the large number of awards of extra compensation to their employes by many companies as a means of dividing the enormous profits of the past year. In some instances this award has reached the amount of ten per cent of the employe's yearly earning, and in a few cases even higher. In other plants, less fortunate in securing "velvet" on their product, there has been no fund available for a bonus; and in consequence there have sprung up unrest and dissatisfaction in the men who chanced to be in the normal shop instead of the one that cut the melon.

But the largest factor tending to show the bonus as undesirable is the case of the average employe who has suddenly been awarded one-tenth of his yearly earning—all in one lump, instead of spread over a number of semi-monthly or weekly pay-days.

This lump bonus was regarded, by some plant officials, as a convenient "nest egg" for a saving account, and was awarded with the idea of foster-

ing savings. But statistics, compiled by various banking officials in some localities and safety men and other welfare workers in others, go to show that a majority of the bonus checks have been spent recklessly—following the usual course of "easy come, easy go"—and the only net result of awarding many millions of dollars has been to exalt, temporarily, the social position of some men through their evanescent wealth, and sow the seeds of discontent and to add to the labor problem as the momentarily exalted workers return to their daily or weekly stipend when the surplus has melted.

If the bonus is to be kept good, as its name implies, there must be found some means to tie up the funds so as to prevent their being frittered away in pursuits or purchases which tend to unsettle the workman and lower his economic worth; to be good the bonus must be lasting. Some plants have solved the problem by putting the excess profits into long-time securities for their men; others have spread the money out over a number of pay periods; and still others have utilized the funds in obtaining life insurance on their men, payable to the employes' beneficiaries and untouchable by the men themselves save under special authority from the company making payment on the policies; but there are many companies which, last month, issued lump sum bonuses which will never repeat the experience

—and from them others whose gains this year may mount high may well learn much of value to the next distribution time.

Now that the British war office has slapped him on the wrist, we hope that Josephus Daniels will recognize the truth of "America for the Americans" in the manufacture of war supplies—as surely must be the case if we are drawn into war with any of the present European combatants.

Congress reneged on the Randall zone system for mailing trade papers and other second class matter. Maybe some Western solon found he would have to pay more for his favorite light reading if the "rider" rode the post office bill.

Several British investigators have recently completed exhaustive experiments to determine the earth pressure of large artificial mounds, such as ore or coal piles—with the present railroad em-

bargoes and scarcity of supplies it will be a long time before American superintendents will have to worry about the earth pressures in their now depleted ore and fuel reserves.

It is a good superintendent, now-a-days, who can convert the de-ficiency of his men into efficiency for the plant.

Car dumpers and unloading machines are very necessary in these days of labor shortage, but if cars themselves get much scarcer obsolescence will take the labor-saving devices long before they begin to wear out.

When a switchman will set a switch and then stand in front of the oncoming engine to chat with a fellow-workman (this happened in one of the most progressive large steel plants the other day) there is room for lots of wonder as to what it was that kept that man's hat off his shoulders.

PRODUCTION TOPICS

Micrographical Studies on Copper, Iron and Steel.

In the "Atelier des Essais de métaux de la Cie. des Chemins de Fer. P. L. M." appear the following: Rapid estimation of arsenic in red copper.—By etching the polished metal with pure nitric acid at 22 deg. C. for five or six seconds, black spots are developed, the number of which, it is stated, bears a direct relation to the arsenic content of the metal. By comparing the metal under examination with a prepared scale of standard specimens of known arsenic content the percentage of arsenic present may be estimated to within about 0.06 per cent, as it is claimed. (2) Cutting steel with the oxyacetylene blowpipe.—When sheet or forged steel is cut by means of the oxyacetylene blowpipe, a zone of higher carburization is produced along the cut edges of the metal. Since in the cases examined the width of the zone was about 5 mm., it is considered that the edges of all plates, etc., so cut should be removed for a depth of 10 mm. to insure the absence of affected metal from the finished articles. (3) Effect of cold work on steel.—It is found that the effect of cold work due to threading screws of large diameters is that the metal becomes much harder in the neighborhood of the thread than in the middle, to a depth of 3 or 4 mm.; the ferrite present in this zone was crushed and disseminated in fine needles. It is recommended that, after threading, all coupling-screws should be re-annealed at about 700 deg. C. (4) Adulteration of wrought iron by the insertion of rolled cast steel in the "fagots" may be readily detected micrographically, the pearlitic zones being better defined and more marked when puddle steel has been introduced.

Electric Motor Drive for Bell Hoists.

In the course of a paper presented before a recent meeting of the Pittsburgh Section, Association of Iron and Steel Electrical Engineers, H. D. James presented the following points regarding the use of an electric bell hoist.

The use of electric skip hoists makes it desirable to op-

erate the bell hoists by electric motors. This application of the electric motor is not difficult and the writer sees no reason why it cannot be carried out successfully with either d.c. or a.c. motors. The only obstacle seems to be a certain undefined fear among furnacemen that they may perhaps have trouble because it is a new application.

The bell hoist consists of a crank which makes one revolution in approximately twenty seconds. This crank motion is connected by a cable with a weight. The turning of the crank allows the bell to open through lifting the weight. The travel from the opened position to the closed position of the bell is made with a negative torque, the motor operating as a generator. It may be desirable, therefore, to use 3-1 a.c. motor in order to obtain a slow-down, particularly with the large sized bell.

When the crank has traveled 180 degrees, approximately, and the bell has the maximum opening, it is desirable either to slow down the hoist or stop it for several seconds to insure that the burden slides off the bell and that no pieces remain as this might prevent a proper seal when the bell is closed.

The magnetic contactor control, which is the type applicable to these installations, has passed beyond the experimental stage and magnetic contactors are available which will give long and satisfactory service. The application is an easy one on the contactor and there should be no difficulty from this standpoint. It will be necessary, however, to select a size and design of contactor suitable for the particular motor used, as the selection of an inferior contactor for one of too small a size may lead to disappointment in the outfit as a whole.

The important consideration in furnace control is continuity of service and accessibility for repairs. The control equipment should therefore be rugged and simple. The writer is in favor of eliminating as many automatic features as possible, and making the apparatus tend toward simplicity and ruggedness rather than detail refinement.

Steel Reinforced Aluminum Cables.

For many years the adoption of aluminum conductors for long-distance transmission lines has been found economical. However, owing to the lower tensile strength of this material, it is impossible to pull up such conductors as tightly as copper. The greater sag on the aluminum cables necessitates higher and more expensive towers, and in some cases the economy resulting from the use of the light metal has been more than counterbalanced by this fact. This has been the main reason for the introduction of the steel-center aluminum conductors and the fact that such composite cables have been in use for more than ten years indicates that this project is now beyond the experimental stage.

Among a number of important power undertakings using this type of conductor, two alone employ in the aggregate 70,000,000 pounds of steel-aluminum conductors.

The simplest form is that in which six aluminum strands are laid up around a central steel wire, all of the seven strands being of the same size. This is used for the smallest sizes of cable up to about No. 1, A.W.G. (B. & S.). Larger areas, up to about 225,000 circ. mills, usually have the single steel wire replaced by a seven-wire steel cable of the same area. The ratio of steel to aluminum is the same in both cases. Cables larger than 225,000 circ. mills are usually of thirty-seven or sixty-one strands.

At present, under the average market conditions, a transmission system employing aluminum conductors is frequently cheaper than the equivalent line erected with copper, notwithstanding the higher cost of the towers in the former case. If the towers can be reduced in cost, the economic advantages are more than ever on the side of aluminum, particularly as the extra cost involved by the steel core is trifling. Formulas and data are given for the computation of sag and stress for these composite conductors.

Mixing Blast Furnace and Coke-Oven Gas.

Mixtures of cold blast furnace and coke oven gas have been used as a metallurgical fuel where both were plentiful, but a new gas quality is obtained when the blast furnace gas is drawn into the tops of the coke ovens and allowed to react with the gas already there. Experiments testing this possibility of grading the gaseous fuel have been undertaken by Dr. W. Zimmermann, Worms, Germany, and he finds that the resulting gas called "Verbundagas" by the experimenter—differs in composition from the raw constituents, containing a lessened amount of carbon dioxide and free nitrogen, higher hydrocarbons of both light and heavy grades, and more ammonia. On account of its higher content of combustibles, the calorific value is greater than of the raw material. The experiments suggest that the addition of the blast furnace gas lowers the temperature of the coke oven, and so distillation takes place at a lower temperature than under ordinary conditions. On one set of tests, in which an Otto oven was used, the gain in calorific value ranged from 8. to 13.6 per cent. There therefore appears to be an economy indicated in using blast furnace gas in this way for steel-making. The higher ammonia content, which may be recovered as sulphate, is also valuable, and would make its recovery more profitable than when lower percentages are found in the gas.

Turning Stock During Hammering.

In these days of trade journals and other means for widely disseminating information, it would seem that there would be left no forge shop foreman so unversed in the handling of steel under the hammer as to order it turned in one direction only while being reduced from a large section to a smaller circular one, but this is the case in at least one shop which is turning out large forgings designed

for transmitting heavy torque loads under varying stress.

While watching the shaping of one of these heavy shafts, the writer noticed that the shaft was being turned from one direction entirely, first on ninety-degree turns as the corners were worked into the stock, and then "by the smalls" as the foreman expressed it, as the shaft drew down to nearly the specified size. The entire reduction was carried out by turning the shaft in the one direction, and at no time was there any effort made to counteract the circular travel of the outer stock by working the stock on opposite sides, or through heavy section changes at any one time.

Upon venturing to ask, mildly, if the plan observed did not tend to bring up a sheet of loose steel more or less detached from the central stock, the writer was merely laughed at, and told that that was the way the plant had turned out work, and was the way it would continue to make forged articles.

After much argument a piece of one-inch square stock eighteen inches long of normal carbon, was obtained, and the writer drew down four inches of one end under a spring hammer to a half-inch round at the end, tapering to a three-quarter inch round near the butt end of the draw. This end was worked back and forth, care being taken to work the stock at as near to 180-degree as possible and to avoid any chance twisting of the grain.

The foreman then drew down the other end to approximately the dimensions of the first, working the stock after the shop's accepted plan. Following the completion of the work the bar was taken to a testing laboratory of a near-by automobile plant, and there the bar was cut in one-inch sections over the worked section, and microphotographs made of the ends thus exposed, care being taken to show these in series.

The appearance of the bare ends was enough to convince almost any observer that the writer's stock was much more homogeneous than the foreman's, although the writer never claimed to be a hammerman, and the grain size showed the effect of proper hammering, in being better than that found at the center of the original bar, where no work had been done.

The foreman's end, however, showed clearly defined rings of "travelled" steel, due to the continued rotation of the work in one direction, and particularly to the effect of the lighter forming blows delivered in this way when the reduction was almost reached. The zone disturbance in the samples examined seemed to be at depths varying with the diameter of the stock, and were approximately one-third of the radial distance in from the periphery.

With these samples to go on, a piece of round stock was superficially heated—without allowing the interior to heat up thoroughly—and then hammered. Much to the surprise of the foreman, the outside portion of the piece scaled off, with a serrated cleavage like that hinted at in the microphotographs. Needless to say, the stock is now worked in such a way as to oppose hammer blows as much as possible and to prevent distortions from uniform rotation in one direction.—C. C. L. "The American Drop Forger."

Brittleness in Steel Through Electroplating.

Spring makers and others who have to use small steel sections, to be finished by electroplating, have experienced trouble with the brittleness of the steel after electroplating—for which there has been a tendency of the spring makers to hold the steel producers responsible. To settle the controversy and, if possible, determine the cause of the brittleness, M. DeKay Thompson and C. N. Richardson carried out an investigation at the Massachusetts Institute of Technology, using several sizes of black tempered spring wire. The first experiments were to determine whether a bath containing no

cyanide was harmful. Apparently it was not.

The second set of trials was with a copper cyanide bath, in which the springs broke during plating, when under slight strain. Other tests investigated the effect of the type of electrode, and the variation in brittleness with the distance from the point of support. The cyanide, used as a case-hardening element, was suspected, and tests were run to determine whether or no a case-hardened layer was formed. The wire was tested for carbon before and after being made brittle, and no appreciable change found, so the case-hardening theory was discarded. In order to get a polished cross-sectional surface, according to "Metallurgical and Chemical Engineering," several pieces of wire were clamped between brass strips, with the wire ends slightly projecting. These were then ground down and the whole surface, brass and steel, polished with rouge. The surfaces were etched with a 4 per cent solution of nitric acid in alcohol. No difference was observed in the structure of the steel before and after electrolysis.

The authors exhausted every theory that presented itself, and, although unable to locate the reason, state in their conclusions that the following results may be obtained:

Spring steel becomes brittle when used as a cathode in a hot cyanide solution, either sodium cuprocyanide or simply sodium cyanide. The effect is more pronounced with the simple salt. Brass and phosphor-bronze are not effected.

Brittleness was not produced by the liberation of hydrogen on the steel.

The carbon content was not changed by the electrolysis.

The crystalline structure was not changed by electrolysis.

The brittleness is not produced in annealed wire.

The brittleness is not produced by use as cathode whether the wire is coiled or not bent in any way.

The brittleness is not produced when the wire is used as anode, or when it is suspended in the solution without the passage of electricity.

Removing Old Engine Bases.

In one of the steel plants it recently became necessary to remove the foundations upon which a number of heavy gas-blowing engine units had stood, in order to enable new equipment to be placed between other units which were to be kept in continuous operation. These old foundations were built of cement and brick, and were well bound together. So strongly were they built that the ordinary method of tearing down brick work—with a man and crowbar—promised to consume an unwarranted amount of time—and to subject operating units to the excoriating action of brick dust for a long period.

Blasting of the foundations was impossible on account of the danger to other units and to the men working in the power plant, and so the hammer-and-chisel method seemed to be the only one available until the plan of trying the lime-blasting method was brought forward.

Holes were drilled in the foundations on two-foot centers, using a small air drill for the work, and the holes then filled with about a foot of lime, on top of which water was put down, then more lime added, more water, and so on until the hole was filled to within ten or twelve inches of the top, when dry sand was rammed in to fill.

The lime began to expand at once, and in many instances had begun to break down the lower portion of the foundation even before the holes were entirely filled.

On one foundation the lime plugs showed a tendency to push out, despite the careful ramming given the tamping sand, and drills with the bit sharpened unevenly on the two lip edges were used every foot or so for three or four inches, to keep the smooth bore of the holes from permitting the

lime from being forced out. On those holes which had already been put down, a piece of gas pipe was let into the center of the hole, having first been drilled with a large number of small holes through the portion of the pipe to be buried. Lime was then tamped in for the proper depth of hole, and a cement plug put around the pipe at the top. Then, when all the holes had been prepared, the pipe was filled with water, which was allowed to percolate through the holes and into the lime as it could. This method worked so well that the company expects to employ it hereafter when such "blasting" is necessary.

Ore Transportation in Chile.

The Bethlehem Steel Company recently ordered three 120-ton electric locomotives for use at its mines at Tofo, Chile, for hauling the ore from the mines to Cruz Grande, the shipping point on sea level. These locomotives were built at Erie, Pa., by the General Electric Company, and were completed there and thoroughly tested. Then the engines were dismantled and all parts numbered and tagged before being packed securely in shipping boxes. Each locomotive occupied 62 separate boxes, some weighing more than a ton and being over 50 feet in length, while others would weigh but a few pounds. The boxes were accompanied by plans and blue-prints to enable the men at the receiving point to know which boxes to open first and the method of assembly to be pursued. Each locomotive, when respersed and boxed, weighed 240,000 pounds, and filled eight freight cars as shipped to seaboard for loading aboard ship for South America. The boxing of all parts makes it possible to pack the locomotives properly for the long ocean voyage, and to prevent damage through exposure to salt air which otherwise would be unavoidable.

The railroad from the mines at Tofo to the seaport is unique in braking, the loaded locomotive with its load of filled ore cars generating almost enough current on the down trip to provide for the haulage of the same length of train of empties up the grade to the mine.

AMERICAN IRON AND STEEL INSTITUTE MEMBERS

Members elected to waiting list to be transferred to associate list as vacancies occur.

Carl L. O. Graul, assistant to superintendent, By-Products Coke Corporation, 11200 Torrence Avenue, Chicago, Ill.

George M. Gillette, vice president, Minneapolis Steel & Machinery Company, Minneapolis, Minn.

James L. Record, president, Minneapolis Steel & Machinery Company, 2854 Minnehaha avenue, Minneapolis, Minn.

B. L. Sommer, secretary and treasurer, Keystone Steel and Wire Company, Peoria, Illinois.

Christian Girl, president, Perfection Spring Company, Cleveland, Ohio.

William H. Bailey, engineer, Illinois Steel Company, 208 S. La Salle Street, Chicago, Illinois.

Fred W. Beach, general manager, La Salle Steel Company, 2365 S. Halsted Street, Chicago, Ill.

A. N. Flora, general manager of sales, The Trumbull Steel Company, Warren, Ohio.

Leonard A. Funkhousen, assistant electrical engineer, The Steel Company of Canada, Hamilton, Canada.

D. W. Kerr, vice president, The Trumbull Steel Company, Warren, Ohio.

William M. McFate, secretary, The Trumbull Steel Company, Warren, Ohio.

Fred Wille, chief engineer, The Trumbull Steel Company, Warren, Ohio.

J. P. Hilands, sales manager, The Ohio Seamless Tube Company, Shelby, Ohio.

INDUSTRIAL SAFETY

First Aid for Open Wounds.

By DR. C. C. ROBINSON, Chief Surgeon, Inland Steel Co.

First aid has for its primal purpose the rendering of the right sort of care to every injured person, and prompt placing of him in the hands of an experienced and capable physician, from whom the man may receive such treatment and care as will most speedily and safely bring about an early and complete recovery.

The healing, the lessening of the destructive tendency of every wound, is dependent upon the prevention of infection. Infection implies the entrance into the wound of microscopic bacteria. Such bacteria, or germs, grow in the wound, cause inflammation, redness, increased pain, destruction of tissue and the formation of pus. When present, they prevent healing, increase the damage, prolong the recovery and frequently cause constitutional symptoms such as fever, prostration, exhaustion and even death. A wound that becomes infected is prone to cause a larger scar, greater loss of function of the part and aggravate what at first may have been but a trivial injury.

Bacteria gain entrance to a wound by their presence on the skin at the time of sustaining the injury, by being introduced into the wound by the object that caused the injury, or by the implantation in the wound after the sustaining of an injury. Bacteria are not visible to the naked eye; they have the power of multiplying so rapidly that 500 bacteria, after the lapse of a few hours, may increase to 100,000, and in a few days to millions.

Open wounds should merely be wrapped in sterile gauze and bandages obtained in Stretcher Stations, taking care not to touch that part of gauze or bandage placed over wound. Blood is the best dressing, the best antiseptic, and the best salve. Never touch the wound with your fingers; never suck wounds or do anything except to wrap with bandage and get patient to doctor.

Don't neglect to have slight injuries treated as soon as possible after accident occurs, as the slightest injuries may become infected and death may result.

By DR. LOYAL A. SHOUDY, Department of Safety and Welfare, Bethlehem Steel Company, Bethlehem, Pa.

I have noted from many of the large plants handbooks on "Safety and Accident Prevention," telling all about the safeguards on the machinery, how to handle them, etc. And in some instances they have thought little ways and inserted a few lines on what to do when you cut your finger, etc. Why not issue a booklet on "How to Live," and set forth for the men things that should be done in order to have the human machine able to cope with the day's work? Of what value is a perfectly guarded lathe if the operator is not physically fit?

Physical examination is a big step in the right direction, and with this must go advice from the examiner and given in such a way that the man will feel that you are not merely there to keep him from a job, but that your examination is for his good, to point to him his weakness and to help him to overcome this and perhaps throw out the first lesson in personal hygiene.

Our plant physicians and visiting nurses should teach health as they meet the occasion. When a man comes to the

plant hospital for treatment and an occasion opens for a little health advice, give it, tell him where he is wrong, and help him to see that such things are for his good—his health. The visiting nurse should impart health all along the line. Meet conditions as they are, each in his own little world, and watch results, not in a day nor in a week, but in a year or years. Use the movies, playground and any means at your command. Educate the force to the necessity of personal hygiene and follow this to the homes. Use booklets and bulletin boards. If your shop has safety committees make them "health committees." Teach them hygiene shop and personal. Along with guards for saws and wheels teach them to guard the human machine. You place guards throughout your plant; teach them that the eyes, ears, nose, etc., were given for a purpose and to use them for that purpose. Use the foreman, teach him to watch his men, to send them to the plant physician without delay. Teach him the value of the eyes, hands and feet and to this end make him his brother's keeper. Now all go home remembering that you are teachers. Use the superintendent, point out to him that his shop must be clean, have proper light, heat and ventilation.

SAFETY FIRST.

George Ade says that a friend of his in Bridgeport, Conn., had a colored boy working for him as janitor. One morning the darky announced that he was about to quit.

"I laks you, Mistah Blank," he explained to Ade's friend, "and I ain't got no fault to find wid dis heah job. But dey tells me dat over heah at dese munitions works dey's payin' fo' dollahs a day. And I 'lows to git some of dat easy money."

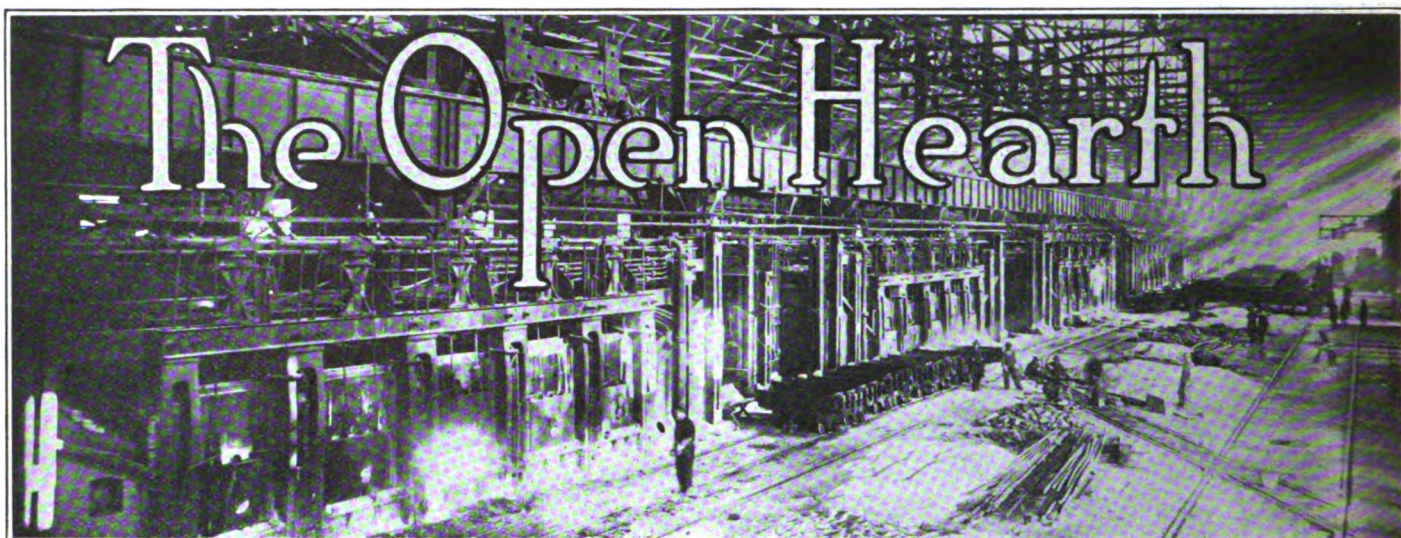
Being paid off, he departed. Two days later he came back and applied for his former place.

"Didn't you care for the new job?" asked Mr. Blank.

"I quit 'fo' I got dat far," stated the negro. "Yesterday mornin' I goes over to dem munitions works and I tells de man in de little office at de gate in de big high wall outside dat I'se done come to get one of dem fo'-dollah-a-day jobs of his'n. He says 'all right,' and den he gits out a book and axes me whut is my name? I tells him whut is my name; and den he say: 'Whar do you want de remains sent?' And I look him in de eye and I say: 'Boss, don't you pester you'se'f 'bout de remains, 'ca'se I'se gwine take 'em with me right now.'"—Saturday Evening Post.

DUAL CARELESSNESS.

Not very long since a dinky brakeman in the bessemer department of the Youngstown Sheet and Tube Company, sent an engine in on a track to pull out some mold cars. He stood at a cross-over that the engine would have to pass over in coming out, with his back to the engine, and began to talk to a fellow laborer. The engineer coupled to the cars and started to back out. He did not ring his bell, or blow his whistle. When the cross-over was reached the brakeman failed to hear or see the engine, was hit and knocked down. His right foot was crushed necessitating amputation. Here is a serious accident due to the carelessness of both the injured and a fellow employe, the engineer of the dinky. The best safety device in any plant is a careful man.



Robert Schubert, consulting metallurgical engineer, has left for Stavanger, Norway, where he will be metallurgist with the Stavanger Electro Stallwerk.

V V

L. E. Thomas, general manager of the Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa., has been made vice president of the company, and now is vice president and general manager.

V V

Asa Moore, who has been assistant superintendent of blast furnaces at the Farrell plant, Carnegie Steel Company, Farrell, Pa., has been transferred to the New Castle Works of the company and is now assistant superintendent at that plant.

V V

H. C. Pringle, formerly connected with the mechanical department of the Aliquippa Works of the Jones & Laughlin Steel Company, Woodlawn, Pa., is now assistant master mechanic for the Franklin Mills of the Cambria Steel Company, Johnstown, Pa.

V V

Samuel G. Hibben, formerly head of the engineering department of the Macbeth-Evans Glass Company, Pittsburgh, Pa., and associated with the Westinghouse Electric & Manufacturing Company, has recently become associated with the Westinghouse Lamp Company, with his headquarters in the Pittsburgh office of the company.

V V

Edwin N. Corey, for the past several years superintendent of the Rolling Mill mine of the Jones & Laughlin Ore Company, has been promoted to the position of assistant superintendent of the company's Marquette, Mich., and Menominee range mines, with headquarters at the former place.

V V

George E. Harris, who has been connected with Carnegie Steel Company at the Edgar Thomson Steel Works for the past twenty-seven years has resigned and will retire from the industry. His last position prior to resignation was head of the finishing departments of the four rail and sheet bar mills. He began his connection with steel making with the old Bethlehem Iron Company nearly forty years ago.

V V

Barton R. Shover, recently returned from Sakchi, India, where he was general manager of the Tate Iron & Steel Company, and previous to that general superintendent of the Brier Hill Steel Company, Youngstown, Ohio, having been connected for twenty-two years with the industry, has

opened offices at 704 Diamond Bank Building, Pittsburgh, Pa., as consulting engineer on steam and electrical applications in the iron and steel industry.

V V

C. E. Corson, formerly with the Bethlehem Steel Company, is now metallurgist and, temporarily, assistant general manager for the Edgewater Steel Company, Pittsburgh, Pa.

V V

H. H. Roberts, assistant chief engineer, the LaBelle Iron Works, Steubenville, Ohio, has been promoted to the position of chief engineer, vice W. Forsstrom, resigned.

V V

W. W. Taylor, vice president and general manager of the Oriskany Ore & Iron Corporation, Lynchburg, Va., has resigned.

V V

C. E. Middleton has resigned as general manager of the Carbon Steel Company, Pittsburgh, to become vice president of the Penn Seaboard Steel Corporation.

V V

Andrew Bryson has resigned as president of the Brylgon Steel Casting Company, New Castle, Del., and has severed his connection with that company.

V V

H. M. Zuck has been made traffic manager of the Lukens Iron & Steel Company, Coatesville, Pa. He formerly was in charge of the shipping department.

V V

H. H. Maury has been appointed manager of furnaces and ore mines of the Virginia Iron, Coal & Coke Company, with office at Roanoke, Va.

V V

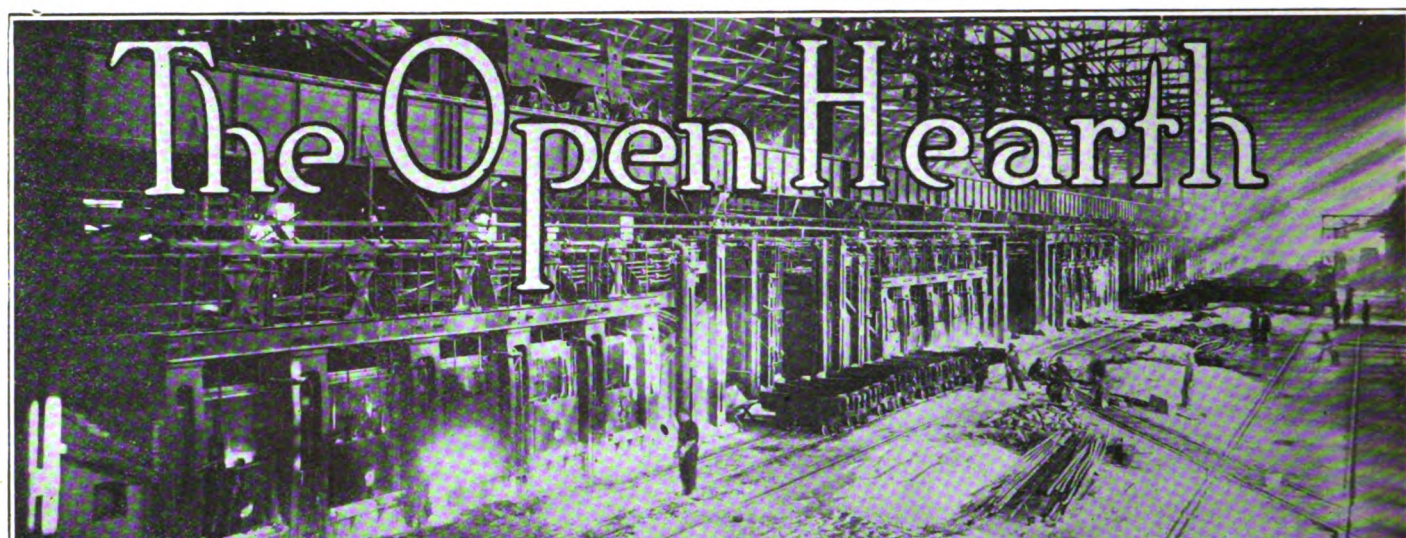
L. C. Parrott is now purchasing agent for the Otis Steel Company, Cleveland, Ohio. He was formerly assistant purchasing agent for the Standard Parts Company, also of Cleveland.

V V

William Forsstrom, chief engineer for the LaBelle Iron Works, Steubenville, Ohio, has resigned to become chief engineer for the Youngstown Sheet & Tube Company, Youngstown, Ohio.

V V

Earl S. Shartzer, formerly with the Pennsylvania Steel Company, Steelton, Pa., the Harrisburg Pipe and Pipe Bending Company, Harrisburg, Pa., and later with the Pittsburgh Crucible Steel Company, Pittsburgh, Pa., has left for Christiana, Norway, where he will supervise the erection



of a carbon factory there, ultimately becoming operating engineer for the company upon completion of the construction work.

✓ ✓

P. C. Pickrel has joined the sales force of the Vanadium Alloys Steel Company under C. M. Bigger, general manager of sales, at Cincinnati, Ohio.

✓ ✓

F. B. Longanecker, who recently resigned from the Enterprise Manufacturing Company, Columbiana, O., is now connected with the Vanadium Alloys Steel Company, Pittsburgh.

✓ ✓

William G. O'Malley, manager of the Midland plant of the Pittsburgh Crucible Steel Company, has been elected a director of the Midland Savings and Trust Company, Midland, Pa.

✓ ✓

Harry Robinson, electrical department superintendent of the Worth Brothers plant of the Midvale Steel & Ordnance Company Coatesville, Pa., has resigned to become affiliated with the new Worth Brothers plant at Claymont, Del.

✓ ✓

George W. Knopf, who recently resigned as assistant manager of the Pottstown, Pa., plant of the McClintic-Marshall Company, has opened an office in the Pennsylvania building, Philadelphia, as a consulting engineer.

✓ ✓

N. M. Emerick, formerly with the traffic department of the Brier Hill Steel Company, Youngstown, Ohio, has resigned to become traffic manager for the Wilkoff Brothers Company, of that city.

✓ ✓

John O. Pew, president and general manager of the Youngstown Iron & Steel Company, Youngstown, Ohio, has tendered his resignation, effective February 15. He will retire from active business at that time.

✓ ✓

Harry C. Evans, for some years chief surgeon of the Carnegie Steel Company in the Youngstown district, has departed for France, where he will join the American ambulance corps for active work on the battlefields and in the hospitals.

✓ ✓

C. E. Bertie, who has been connected with the sales department of Rogers, Brown & Company, most recently in the Philadelphia office since 1906, has resigned to become assistant to the president of the Virginia Iron, Coal & Coke

Company, Roanoke, Va. He assumed his new duties January 22.

✓ ✓

E. J. Parrock, who has been connected with the steam engineering department of the Youngstown Sheet & Tube Company, Youngstown, Ohio, for several years, has resigned to accept a position with the Canadian Steel Corporation, at Ojibway, Canada.

✓ ✓

H. H. Pleasance has been appointed assistant general manager of sales of the United Alloy Steel Corporation, Canton, Ohio. His headquarters will be in Canton and Cleveland.

✓ ✓

E. A. Amaden superintendent of the Waverly warehouse of the Carnegie Steel Company, Newark, N. J., effective January 1, was appointed general superintendent of all the warehouses operated by that company. He will have offices in the Carnegie building, Pittsburgh.

✓ ✓

John J. Griffin, for 23 years connected with the Carnegie Steel Company, has been appointed auditor and assistant treasurer of the American Steel Export Company, Woolworth building, New York City. He is an expert accountant and much of his time with the Carnegie company was spent in the bureau of vouchers and the bureau of freights.

✓ ✓

G. C. Baldwin, superintendent of the Perth Amboy, N. J., plant of the Standard Underground Cable Company, is to supervise the construction of large extensions to the Glen-Willard plant of the company near Pittsburgh. These will include a new rod mill and a cable plant. These additions recently were scheduled to be built in Perth Amboy, but due to the difficulty the company has encountered in making railroad shipments at that point, it was decided to build them at Glen-Willard.

✓ ✓

Carl A. Wendell has severed his connection with the Joliet works of the Illinois Steel Company, to take the position of chief engineer of the American Ore Reclamation Company, 71 Broadway, New York. For the last two years he has been steam engineer at Joliet, and previous to that was in charge of experimental engineering. He has conducted all the experiments for the United States Steel Corporation relative to the treatment of coal by washing and other means of concentration. He has had a wide experience in designing, constructing and operating at various steel works in this country.

Some Pointers on By-Product Coke Oven Operations

When certain coals are heated, the particles swell up or intumesce, and finally agglomerate into a mass of hard dense coke, in which no trace of the original coal particles can be discerned. These coals are said to coke, and the specimen is called a "coking" coal.

On the other hand if the coal yields a coke which is only very slightly coherent, and which closely resembles the form of the coal particles from which it was derived, the coal is stated to be a "non-coking" coal.

Coals in which the caking property is highly developed, and which have a high fixed carbon content, are naturally in great demand for the manufacture of coke, and are known as "coking" coals. The term, coking coal, does not necessarily cover all caking coals. Some cannel coals give a small yield of moderately good coke, but are far in their chemical composition from being coking coals.

Estimation of the Caking Power of Coal.—It was about 1870 that Richters made an attempt to give quantitative expression to the caking power of a coal. He measured it in terms of the number of parts of sand which one part of the coal could bind into a coherent coke. A coherent coke was considered to be one which was just capable of supporting a kilogram weight without crushing.

The modified form of this test, which is practised to-day was suggested by Campredon.

This estimation consists in heating a mixture of coal with varying proportions of sand, until a non-coherent coke is obtained. Obviously the more sand a coal can bind into a firm coke, the greater is its caking power. For the purposes of comparison the caking power is represented by a number, which expresses the weight of sand that can be mixed with one gram of coal before a powdery coke is yielded. Totally non-caking coals, like anthracite, obviously have a caking power of zero. For a strongly coking coal the value of the caking power may rise as high as 15; that is, 15 grams of sand mixed with one gram of coal just yields a pulverulent coke.

This test is only a rough one and approximate results only can be expected. It is useful, however, when testing and comparing coals of moderate caking power. With coals of high caking power the values obtained almost lead one to suggest that the enormous weight of sand they can bind into a mass, is due to some chemical action taking place between the sand and possibly some of the constituents of the ash. This question needs careful investigation before any definite views can be expressed.

Caking Power and Available Hydrogen.—Attempts have been made to find a relation between the property of caking and the composition of the coal. A few examples will illustrate the work. In the following table is given the percentage of carbon, hydrogen and oxygen in a pure coal, that is, a coal free from ash, sulphur, nitrogen, and moisture. Such a pure coal never occurs naturally, but the percentages of carbon, hydrogen, and oxygen which exist in the pure coal substance may be calculated from the results of a complete analysis. A calculation of the carbon content of a coal will show the method.

Suppose the analysis of a coal to show that it contains 78.91 per cent of carbon and 11.13 per cent as the total of the percentages of moisture, ash, sulphur and nitrogen. This means that there are 78.91 parts of carbon in 88.87 parts of coal free from moisture, ash, sulphur, and nitrogen; there-

fore the percentage of carbon in the pure coal substance is $78.91/88.87 \times 100$ or 88.79 per cent.

Obviously on an ash-moisture-sulphur-nitrogen-free basis the sum of the carbon, hydrogen contents amounts to 100.

Under I. is given the composition of a non-caking coal which is seen to be rich in carbon and approximates to an anthracite (such coals are usually termed semi-anthracites or steam coals).

Under II. are given the values for a good coking coal, that is, a coal with a high caking power. The numbers under III. give the percentages for a non-caking bituminous coal, which is rich in oxygen; these coals are usually called flaming coals:—

	I.	II.	III.
Carbon	91.45	88.79	72.83
Hydrogen	4.32	5.28	6.32
Oxygen	4.23	5.93	20.85
	100.00	100.00	100.00

The excess of hydrogen above the amount needed to combine with all the oxygen to form water (i.e., the percentage of "available" hydrogen) in these coals is—

	I.	II.	III.
Available Hydrogen	3.79	4.54	3.71

It would appear from these numbers that the caking power is dependent on the percentage of available hydrogen, and it is often stated that a good coherent coke will be yielded by a coal which contains more than 4.2 per cent of available hydrogen. This must not be taken as a rigid rule, for the property of caking is not, at present, completely understood. Many cases are known, in which, of two coals possessing almost identically the same percentage composition, one is non-caking and the other caking.

Again, cannel coal, as mentioned previously, has an unusually high available hydrogen content; but its caking power, instead of being correspondingly high, is either moderate or non-existent.

Caking Power and Volatile Matter.—Another suggestion is that a relationship exists between the caking power of a coal and its percentage of volatile matter, but that this is open to a similar criticism to the above will be seen from the following account. It is stated that the caking power gradually increases from zero, for an anthracite, to a maximum for a coking coal, and finally decreases to zero again for a flaming coal. Thus, for a coal yielding up to about 13 per cent volatile matter the caking power is zero; from 13 to 17 per cent it is doubtful whether the coal will cake at all; from 17 to 21 the caking power is moderate; from 21 it rises and reaches a maximum at 26 per cent; from 26 to 40 per cent the caking power decreases to zero.

The same difficulty is met with in the case of cannel coal, which may yield 65 per cent of volatile matter and yet give a fairly good coke.

Influence of Temperature on the Caking Power of a Coal.—When a caking coal is heated to a temperature of 300 deg. to 400 deg. C. for a period of about one hour and a half, it loses its caking property; and, on subsequently heating some of the powdered coal in a closed crucible, the residue is found

(Continued on Page 92)

NEWS OF THE PLANTS

Julian Kennedy, engineer in charge of the design and construction of the new plant of the Keystone Steel & Wire Company, Joliet, Ill., has retained Barton R. Shover, consulting engineer, Pittsburgh, Pa., as consulting electrical engineer on the application of power to the equipment for that plant.

The H. W. Johns-Manville Company has opened its fifty-fifth branch office, it being located in Des Moines, Iowa, at 911 Walnut street. William H. Roberts, who has been with the company for several years in charge of Iowa sales, has been appointed manager of the new office, and will have under him the salesmen and construction men in the new territory.

The Youngstown Chemists' Club has been recently organized at Youngstown, Ohio, the first meeting being held on December 14, 1916. The following officers were elected:

President, Edwin G. Pierce, consulting chemist.

Secretary, Carl W. Weesner, Carnegie Steel Company.

Treasurer, H. E. Moyer, Brier Hill Steel Company.

Officials of the Western Reserve Steel Company, recently acquired by the Brier Hill Steel Company, are planning to enter the steel field again with a mill to be located either at Warren or Leavittsburg, Ohio. C. G. Thomas, president of the Western Reserve Company, is said to be behind the plans for the new company.

Pickling machines for various steel plant uses are described and illustrated in "Bulletin M," published and distributed by The Mesta Machine Company, Box 1124, Pittsburgh, Pa. The bulletin shows the types of pickling machines used for handling varied products and under different conditions. It will be sent upon application to the company.

The Hyde City rolling mills here have been bought by a syndicate headed by Dr. C. F. Henning, of Bellefonte, Pa., and work has been begun on the remodeling of the plant at a cost estimated to total \$250,000. The mills, which are about two miles from Clearfield, Pa., have been down for six years, and are being remodeled for rolling nickel steel bars and titan bronze tubing, as well as other special alloys. The plant is being put in shape for early spring operation.

High cost of steel in Chile and other South American countries since the outbreak of the European War has started Chilean enterprise along lines of steel making. Old iron, formerly exported to Europe, is used as raw material; and the equipment used is patterned after European models. Home made steel, even with inadequate facilities, is said to be 20 per cent cheaper than imported; and is demonstrating the feasibility of Chilean steel making which undoubtedly will lead to further developments of the industry. Native coal is used for fuel, which introduces equipment problems which necessitated the building of a special foundry for making the rolling mill equipment.

The uses of open heaters in connection with the heating, metering and softening of water for boiler and other purposes are exhaustively treated in a 100-page book (Publication No. 710) lately issued by the Harrison Safety Boiler

Works, Philadelphia, Pa. The amount of fuel that can be saved by the use of exhaust steam to heat feed water is first explained, and a diagram is given by which the percentage fuel saving in any given case can be easily ascertained. The book covers in a very complete manner the important matters of handling feed water and exhaust steam, and should be of value to those who design, manage or operate steam power plants.

The Homestead Valve Manufacturing Company, Pittsburgh, Pa., has appointed agents for the following territory: Seeger-Walraven Company, Atlanta, Ga.; Joplin Supply Company, Joplin, Mo.; and George T. Matthews & Company, St. Louis, Mo.

The shop employes of The Cutler-Hammer Manufacturing Company, of Milwaukee, all received a Christmas present in cash the 23rd of December and before New Year's Day a notice was posted which advised everyone of a bonus of 10 per cent of the yearly wages or salary. This bonus goes to all of the 2,400 employes of this company.

John W. Hubbard, president of Hubbard & Company, and the National Nut & Bolt Company, both of Pittsburgh, has bought controlling interest in the Standard Engineering Company, Ellwood City, Pa. Large additions will be made to the plant, which is at present turning out a line of tube-mill machinery, rolling-mill equipment, and allied lines, together with a full line of castings. After February 1 a re-organization will be made, with the new owner as president.

Following twenty-two years in the steel industry, during which time he has been actively connected with the design, construction and operation of electrical and steam power application to the iron and steel industry, Barton R. Shover has opened offices as consulting engineer in these lines at 704 Diamond Bank Building, Pittsburgh, Pa. Until recently Mr. Shover was general manager of the Tata Iron & Steel Company, Sakchi, India, and previous to that general superintendent of the Brier Hill Steel Company, Ohio. He began his work in the electrical end of the steel industry with the Carnegie Steel Company, being at one time electrical engineer for the Youngstown district. He was also electrical engineer on the Gary plant of the Indiana Steel Company, the first plant in the world to adopt the electric drive throughout, and is conversant with the application of electricity to the steel industry from the days when the entire electrical equipment consisted of a few lights and a crane or two to the present, when electric drive is used throughout the plant in many instances. He is a member of the American Iron and Steel Institute, fellow of the American Institute of Electrical Engineers and past president and one of the founders of the Association of Iron & Steel Electrical Engineers.

We have recently received from the George T. Ladd Company, Pittsburgh, Pa., copy of the new catalogue describing the Ladd water tube boiler. The name of this boiler has been changed from the "Milne" to that used at present. The reason for this is that, since the purchase of the Milne patents some years ago, the Ladd company has carried out development of the former Milne boiler with regard to the improvement of settings, feed boxes and many other details

to the extent that the majority of the patents now being used on this boiler are taken out in the name of George T. Ladd, president of the Ladd company. The boiler now will be known by the name which most nearly describes the source of design and construction. The new Ladd boiler catalogue describes the new features of the boiler, and shows typical settings and installations. It will be sent out by the Ladd Company on request.

A new type of boiler, with the object of eliminating the smoke nuisance and saving by-products from coal, has been designed by George Wilkinson, borough electrical engineer of Harrogate, England. The patent claims are:

The coal is distilled, yielding tar and ammoniacal liquor.

The coke obtained gravitates while incandescent into the furnace, being consumed there without smoke.

The gas after removal of by-products, is passed into the furnace under considerable pressure with the necessary air; it burns with a smokeless flame until it enters the retort flue, where it is transformed into radiant heat, absorbed partly by the retort and partly by the water of the boiler. Active steaming surfaces are produced not only in the furnace but on the whole flue surface.

The inventor expects to get from 20 to 25 pounds evaporation per square foot of heating surface. The boiler is automatically fed with coal which passes automatically through the various stages of distillation and combustion.

RECENT PATENTS

The following patents are reported expressly for The BLAST FURNACE AND STEEL PLANT, from the patent law offices of Norman T. Whitaker, Legal Building, Washington, D. C., (opposite U. S. Patent Office), from whom copies of any one of the patents may be obtained by sending fifteen cents in stamps.

A process for the recovery of metals from ores and the like has been invented by Charles S. Vadner, of Butte, Mont., and patented as No. 1,207,243. The gist of the claim is as follows: In the art of recovering copper and other metals from mineral matter and the like consisting in treating the naturally oxidized or sufficiently roasted sulfid ore with sulfurous gases and the like in the presence of heat and a solution containing at least one of the common chlorides that can react, for the purpose of effecting the desired reactions, leaching out the metals from the mineral matter eliminating excess acidity of solution, passing air through same, further eliminating excess acidity of solution and sufficiently heating same whereby copper is precipitated as cuprous chlorid.

Patent No. 1,211,715 on a method of welding a protective covering of copper to an iron or steel body has been invented by John Kirby, of Pittsburgh, Pa. The inventor claims substantially as follows: A method of welding a protective covering of copper to an iron or steel body comprising the softening of the inner face of a solid copper body by bringing into gradual contact with said inner face the metal to be protected when in a molten state and at a temperature from 2400 degrees F. to 2600 degrees F., and then allowing the molten metal to cool to cause the solidification of such metal with the copper thereby setting up a perfect weld between the copper and the solidified metal.

Mr. George W. Wright of Deming, N. Mex., has just been issued a patent on a process of and apparatus for smelting ores. The inventor claims among other features: An apparatus comprising a retort, an agitator being provided with an operating device which extends through a wall of the retort, and means for closing said retort to exclude air from the interior thereof, said means including a universal bearing in which said operating device is slidably mounted. The number of this patent is 1,211,865.

Patent No. 1,211,249 on a method of making car-wheels

has just been invented by Clifton W. Sherman, of Buffalo, N. Y., and the inventor claims the method of making car wheels having a hub, a flanged tread and a body connecting the hub and flanged tread, which comprises casting the flange of the tread and the adjacent bearing surface of the tread against a chiller, and forming the flanged tread and that part of the body in line therewith comparatively rapidly and at a uniform rate of pouring of the metal into the cold cavity, as compared with those parts above and below the same the formation of the flange and load line portions of the tread being effected substantially while that part of the hub about midway between its upper and lower ends and the adjacent part of the body are being formed.

Joseph M. Flannery, of Pittsburgh, Pa., has been granted three patents on high-speed steel, which are numbered as follows 1,210,625; 1,210,626 and 1,210,627. He claims substantially as follows: High speed steel containing uranium as the sole added toughening agent. Steel having uranium incorporated therein and constituting the sole added element necessary to form high speed steel. High speed steel comprising steel having uranium alloyed therewith in the proportion approximately as specified. High speed steel having alloyed therewith as the sole added toughening agent, a proportion of uranium as ranging from .05 per cent to 5 per cent.

2.—High speed tungsten steel having uranium alloyed therewith, the uranium replacing a portion of the tungsten used in ordinary tungsten steel. High speed steel containing tungsten and uranium in approximately the relative proportions specified. High speed tungsten steel having uranium alloyed therewith in proportion less than the proportion of the tungsten content, the uranium replacing a portion of the tungsten used in ordinary tungsten steel. High speed tungsten steel, having uranium alloyed in a proportion as high as three per cent uranium, the uranium replacing a portion of the tungsten used in ordinary tungsten steel. High speed tungsten steel, containing approximately eight per cent tungsten and approximately three per cent uranium.

3.—High speed molybdenum steel having uranium alloyed therewith, the uranium replacing a portion of the molybdenum used in ordinary molybdenum steel. High speed steel containing molybdenum and uranium in approximately the relative proportions specified. High speed molybdenum steel having uranium alloyed therewith in proportion less than the proportion of the molybdenum content, the uranium replacing a portion of the molybdenum used in ordinary molybdenum steel.

George A. Dornin of Baltimore, Md., is the patentee on an ingot-mold disclosed in his patent No. 1,210,774.

Patent No. 1,210,724 on a method of recovering Valuable Constituents of Ores, has just been patented and issued to Hermann G. C. Thofehrn, of Pittsburgh, Pa. The gist of the invention is as follows: The method consisting in discharging pentoxid of nitrogen gas into an aqueous mixture of comminuted ore.

Leo. M. Fink, of Montreal, Quebec, Canada, has been granted Patent No. 1,210,292 and No. 1,210,293. The former patent being on a mold for making individual teeth for diamond saws, and the latter on a diamond-retainer for diamond saw molds.

Patent No. 1,209,841 on a welding composition has been invented by John A. Hope, of Montreal, Que. Canada, and patented as No. 1,209,814. The inventor claims a high speed steel and low carbon iron welding composition consisting of 80 per cent ferro-manganese, 60 parts; 50 per cent ferro-silicon, 20 parts; and burnt borax 20 parts. A high speed steel and low carbon iron welding composition consisting of ferro-manganese, ferro-silicon and burnt borax.

Ethan I. Dodds, of Pittsburgh, Pa., assignor to Flannery Bolt Company of Pittsburgh, Pa., has invented a Method of manufacturing bolts which is disclosed in Patent No. 1,209,947.

A casting-machine has been invented by Eduardo Castaneda, of Monterey, Mex., which has been patented as number 1,209,116, and has assigned one-half to Jose Belden, of Monterey, Mexico. The inventor claims among other features: A casting machine, a pot for molten metal, a molten metal

displacing member to raise and lower the liquid level in said pot, a mold member adjacent the pot, means to move the displacing member into the metal to cause it to flow into said mold member, and means to return the surplus metal to the pot.

Patent No. 1,209,039 on an apparatus for pouring steel and producing ingots, bars, etc., has just been issued to John T. Rowley, of Pittsburgh, Pa., and assigned to the Superior Pouring Metals Company, Johnstown, Pa., a Corporation of West Virginia. The gist of the invention is as follows: An apparatus including a comparatively large expansion chamber, a plurality of restricted conduits leading to the expansion chamber, means for casting metal to enter the expansion chamber through the plurality of restricted conduits, and means for discharging the metal from the expansion chamber.

Emil Gathmann of Baltimore, Md., has invented an Ingot-Mold, disclosed in his patent No. 1,209,283.

A process of breaking steel bars has been invented by Pierre Victor Leon Bellanger, of Paris, France, and patented as No. 1,209,250, which is as follows: A process of the character described for breaking metal bars, consisting in subjecting said bars to the action of a reducing flame at the point where the bar is to be broken for changing the consistency of the metal at this place, and finally subjecting the bar to the action of a breaking tool.

Mr. Thomas McDonald, of Youngstown, Ohio, has just been issued a patent on a blast-furnace casting apparatus, which is patented as No. 1,210,091. The inventor claims substantially as follows: The combination with a blast furnace having a tapping hole, a skimmer trough leading from said tapping hole, and a main trough leading from the skimmer trough, of car tracks having ladle cars thereon, an adjustable trough leading from the main trough to said ladle cars, and means for moving said adjustable trough to divert and control the flow of metal from the main trough into either or both of two of said ladle cars.

Pointers in By-Product Coke Oven Operation.

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to be a powdery coke. If the coal is only submitted to a temperature of 300 deg.—400 deg. C. for a short time (15 minutes), the caking power does not appear to be diminished to any sensible extent. The loss of caking power is supposed to be due to either the volatilisation or oxidation of those products in the coal, which endowed it with this particular property.

Influence of the Rate of Heating on the Caking Power of a Coal.—The caking power of a coal seems to be dependent to a certain extent on the manner in which the coal is heated. Thus, certain coals, when heated in the usual manner, yield pulverulent cokes which are of no commercial value; if however, the coal is charged into a vessel, which is at a bright red heat, it is raised thereby rapidly to a high temperature. This rapid rate of heating produces a strikingly peculiar change, in that a good coherent coke is obtained. It may be suggested therefore that, if the necessary conditions can be ascertained and industrially fulfilled, many coals of low caking power may be induced to yield satisfactory and profitable cokes.

Influence of Storage on the Caking Power of a Coal.—A peculiar characteristic which some coals exhibit, is that they lose their caking power when stored for any length of time. Some lose the property after one or two days exposure to the atmosphere. A possible explanation of this exceptional feature is that the coal absorbs oxygen from the air; and those products in the coal, upon which it depends for the property of caking, are oxidised to inert compounds.

(Concluded Next Month.)

After the first of March, the offices of Wm. B. Scaife & Sons Company will be in the First-Second National Bank building, Pittsburgh, instead of being at 221 First avenue, the old location of the company.

The plant of I. M. Jacobson & Sons Company, Detroit, Mich., manufacturers of white metal alloys, bearing metals and solder, has been enlarged by the addition of a cupola smelting furnace of five tons daily capacity and a large reverberatory sweat furnace. The new equipment will bring the company's total daily capacity up to 40,000 pounds of refined pig metal per day.

On February 1 at the Franklin Institute in Philadelphia C. J. Ramsburg, vice president of H. Koppers Company, at a joint meeting of the Franklin Institute and the Philadelphia Section of the American Society of Mechanical Engineers, will read a paper entitled "By-Product Coke and Coking Operations." The paper will be illustrated by lantern slides and a moving picture film showing the operation of a by-product coke plant.

Some years ago a well-known combustion engineer made the statement that mechanical soot blowers would eventually be universally considered absolutely necessary to the proper operation of any high pressure boiler.

Each year the necessity for mechanical soot blowers has become more and more apparent. Now the Babcock & Wilcox Company announces that it has adopted diamond mechanical soot blowers, built by the Diamond Power Specialty Company of Detroit, as standard equipment for all boilers they build.

OBITUARIES

Charles Cyrus Ramsey, president of the Crucible Steel Company, died on January 11, following on illness of five weeks. He began his connection with the steel industry when 23 years of age with Park Brothers & Company, Pittsburgh, remaining with the Park Steel Company, successor to Park Brother & Company, until the company was absorbed by the present Crucible Steel Company of America. In July, 1910, he was elected president of the Crucible Steel Company, and shortly thereafter, of its affiliated companies—positions which he held until his death.

William Root, superintendent of the New Castle, Del., plant of the American Manganese Steel Company at the time of his death last month, began his iron-making career with the Ellis & Lessig Iron Company, following with the Chester Rolling Mills, Thurlow, Pa., with which company he remained until 1883. In 1910 he became associated with the Edgar Allen Manganese Steel Company, Chicago, Ill., and remained with that company under its shortened name until his death.

James B. Baird, prominent in the iron and steel industry for many years, died at Cincinnati, on January 2nd. He began his connection with the industry early, his first position of prominence being with the Elwood Iron Works, Elwood, Ind., then making tinning machinery. Later he was in charge of the Cincinnati Rolling Mill, until it was taken over and dismantled by the American Sheet & Tin Plate Company. He then became interested in the Chester Tin Plate Company, at Chester, W. Va., until it, too, was taken over by the Steel Corporation. His last connection was as president and general manager of the National Roll & Foundry Company, Avonmore, Pa., which position he held until his death. He was the inventor of the Baird water-cooled standing and the Baird automatic roll-scouring device and many other sheet and tin mill devices.

Steel Plant Incorporations and Construction

Shelton, Conn.—The Driscoll Wire Company has been incorporated here by William F. Driscoll, Ansonia; Edward E. Gardner, Shelton; and Charles Marvin, Darby; with a capital of \$30,000 to do wire drawing and manufacture wire products.

Sparrows Point, Md.—The Bethlehem Steel Company is now taking bids on a shearing building, to be 1000 feet long, which is planned to be added to the plant here at an early date.

Sparrows Point, Md.—The H. Koppers Company has awarded contract for concrete pile foundation for the by-product coke ovens to be erected here for the Bethlehem Steel Company to the Raymond Concrete Pile Company, New York.

Worcester, Mass.—The American Steel & Wire Company plans to build a wire nail plant here at its Central Works, to cover an area 70 x 334 feet, one-story.

Mansfield, Mass.—The New England Drawn Steel Company has awarded the contracts for two one-story buildings, 50 x 250 feet and 4 x 50 feet, respectively, to be used for housing additions to the present plant.

Ecorse, Mich.—The International Steel Tube and Rolling Mills has bought a site here and will at once put through plans and construction of a 50-ton tube mill. H. K. Flagler is president and general manager, and is already on the ground supervising work.

Harrison, N. J.—The Crucible Steel Company has had plans prepared for a \$200,000 addition to be built between Sixth and Seventh Streets to connect with the present plant.

Jersey City, N. J.—Joseph T. Ryerson & Company, head offices at 30 Church Street, New York City, have plans for a one-story 50 x 150 foot warehouse to be erected here in the near future.

Auburn, N. Y.—The Cayuga Tool Steel Company has been incorporated with a capital stock of \$300,000 to manufacture iron, steel, furnaces and mills, by A. B. King, J. H. Richards and H. D. Canaday, 2114 Canton Avenue, Brooklyn, N. Y.

Dunkirk, N. Y.—The Atlas Crucible Steel Company, which has been planning for some time on the erection of a roll-

ing mill, has let contracts for the same to the McClintic-Marshall Company, Pittsburgh, who will erect a one-story rolling mill building, 70 x 400 feet in extent.

Lorain, Ohio—In the work on the dock extensions for the National Tube Company here the Raymond Concrete Pile Company has been awarded contract for foundation piles. F. W. Mark Construction Company is general contractor.

Warren, Ohio—The Basic Steel Company has purchased a 60-acre tract between here and Niles, and has practically completed its plans for a new sheet steel mill to be erected thereon.

Beaver Falls, Pa.—The Darlington Steel Casting Company's plant, at Darlington, Pa., burned the night of January 19th. The plant was recently purchased by Charles H. Schoen, Philadelphia, and will be rebuilt at once, it is understood, in order to resume the full-time work which was going on at the time of the fire.

Clairton, Pa.—The Carnegie Steel Company has awarded to the Rust Engineering Company, Farmers Bank Building, Pittsburgh, contract for ten reinforced concrete chimneys, 9.5 foot diameter x 200-foot high chimneys for the new Koppers by-product coke plant being erected here.

Erie, Pa.—The Griffin Manufacturing Company, making cold-rolled strip steel, is having erected a steel and brick annealing and heat-treating building, 108 x 152 feet in extent, and will equip the addition when completed.

Lancaster, Pa.—The Penn Iron Company, which has been down for the past ten years, has been recently acquired by New York City capitalists, and will be put into shape for the rolling of steel bars. Operations will begin on a small scale by February 1, it is hoped.

Marietta, Pa.—The old Vesta furnace, which has been down for several years, will be put in shape by Philadelphia interests as soon as possible, and will be used in producing ferro-manganese.

Philadelphia, Pa.—The Goodwater Graphite Company, Inc., has been incorporated with a capital of \$550,000 to manufacture steel, iron and graphite. The incorporators are W. L. Shumate, Jr., of Birmingham, Ala., and Eugene

Argo and T. D. Eppes, of Goodwater, Ala.

Cobourg, Ont., Canada—The Federal Steel & Foundry Company is planning to erect a steel plant and rolling mill here in the near future. Plans and specifications are under the charge of J. H. Cole, manager, in care of the Corbett Foundry & Machine Company, Owen Sound, Ontario.

IRON AND STEEL QUOTATIONS

COMPARED WITH PRICES OF A MONTH AGO

PIG IRON.

Pittsburgh*—	December 27	January 24
Bessemer	35.95	35.95
Basic	30.95@ 31.95	30.95@ 31.95
No. 2 foundry	31.95@ 32.95	31.95@ 32.95
Malleable	30.95	30.95
Gray forge	29.95	29.95
Ferro-silicon, 50%	98.00@100.00	100.00@120.00
Ferro-silicon, 10%	40.00@ 42.00	40.00@ 42.00
Ferro-mang., 80%	160.00@165.00	170.00@175.00
Spiegeleisen, 20%	50.00@ 55.00	50.00@ 55.00

* Pig iron prices quoted here are at Pittsburgh, with freight rate from Valleys to Pittsburgh, 95 cents added.

Virginia Furnaces—

Basic	27.25	27.25
No. 2X	26.75@ 27.75	27.25@ 28.25
No. 2 plain	26.50@ 27.50	27.00@ 28.00
Gray forge	25.50@ 26.00	25.50@ 26.00

Birmingham—

No. 2 foundry	24.00@ 25.00	24.00@ 25.00
No. 3 foundry	23.50@ 24.50	23.50@ 24.50
Gray forge	23.00@ 24.00	23.00@ 24.00

Philadelphia (del.)—

No. 2 foundry	29.50@ 30.50	30.00@ 31.00
No. 2 plain	29.00@ 30.00	29.50@ 30.50
Basic	30.00	30.00
Gray forge	28.25@ 28.75	28.25@ 28.75

Chicago (at fur.)—

No. 2 foundry	30.00	31.00@ 32.00
Malleable	30.00	31.00@ 32.00
Basic	30.00	31.00

Cincinnati (del.)—

Northern No. 2 fdy	31.26	31.26
Basic	31.26	31.26
Nor. malleable	31.26	31.26

STEEL.

Tons of 2,240 lbs., at Pittsburgh.

Bessemer billets ..	60.00@ 65.00	65.00@ 70.00
Open hearth billets ..	60.00@ 65.00	65.00@ 70.00
Forging billets	80.00@ 85.00	80.00@ 85.00
Sheet and tin bars ..	60.00@ 65.00	65.00@ 70.00
Wire rods	70.00@ 75.00	75.00

FINISHED PRODUCT.

Tons of 2,000 lbs., at Pittsburgh.

Skelp, grooved	57.00	57.00
Skelp, sheared	60.00	60.00
Sheets, No. 28	90.00@100.00	90.00@100.00
Galvanized sheets	125.00@140.00	125.00
Shapes	70.00@ 80.00	70.00@ 80.00
Plates	85.00@ 90.00	80.00
Hoops	65.00@ 67.50	70.00
Bands	70.00@ 75.00	60.00
Steel bars	60.00@ 65.00	60.00@ 62.00
Iron bars	65.00	65.00

Per lb. on large orders:

Tin plate	7.00@ 8.00	7.00@ 8.00
Plain wire	2.95	2.95
Galvanized wire	3.65	3.65
Wire nails	3.00	3.00
Galvanized nails	4.00	4.00